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ENGINEERING AND EQUIPMENT

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USSR REPORT
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A RELIABILITY CONCEPT FOR OPTIMIZING AIRCRAFT DESIGN

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ..VIATSIONNAYA TEKHNIKA
in Russian No 4, Oct-Dec 85 (manuscript received 12 Mar 85) pp 7-12

[Article by S.V. Arinchev and V.V. Bystrov]

[Abstract] As the problem of improving aircraft reliability becomes ever more urgent, the area of application of probabilistic methods broadens. According to V.V. Bolotin, scalar reliability function N (Y) is equal to probability P of design quality parameters falling within a specified multidimensional interval. In order to considerably reduce computer time required for calculating P during design synthesis, based on the maximum reliability condition, it was proposed earlier to use the upper P_+ and lower p_- estimates of N. In the abstracted work a different approach was examined. It was assumed that for a P* (0 < P* < 1) a minimum, in a certain sense, multidimensional tolerance Y* should be determined, within which design quality parameters Y fall with probability of not less than P*, i.e. that a solution of a multicriterion minimization problem with a restriction should be derived. The Y* solution of the problem was considered a multidimensional quantile of order P* in the sense of G (where G(Y*) is a convolution function), whereas $G^*_{p^*}$ was considered the quantile value. A design is optimal, when the quantile is minimum. Expressions were introduced that provided an estimate of the actual quantile from below and were expressed in terms of one-dimensional quantiles. Because deriving unidimensional quantiles is much simpler than deriving multidimensional ones, the use of the above mentioned expressions as optimization effectiveness functions can save considerable amount of machine time. In doing this, the value of quantile $G^*_{p^*}$ was considered the reliability function. Feasibility of using the above expressions as optimization effectiveness functions was studied. As a test system, the shock-absorber system of an aircraft with one degree of freedom and random characteristics of the "dry friction" type in the case of determinate input was examined. Derived extremums of the actual quantile were located near the border of the permissible interval. Figures 3, tables 1, references 6: 4 Russian, 2 Western.

12770/9835
CSO: 1861/343

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OPTIMUM TAKE-OFF RUN OF AIRCRAFT ON GROUND AIRFIELDS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 23 Apr 85) pp 12-16

[Article by A.A. Badyagin]

[Abstract] Conditions under which the most favorable for take-off attack angle is small were clarified. It had been alleged by another author that a drawback of this take-off method was a rather long take-off run, especially in the case of poor ground. In the abstracted work the opposite result was obtained: the more the resistance coefficient of ground (the "poorer" the ground), the larger are the optimum attack angle and the aircraft lift coefficient during take-off. It was explained from the physical standpoint by the fact that aerodynamic wing relief not only makes it possible to realize the well known effect of reducing ground resistance forces, but also to reduce the coefficient of resistance to wheel movement. A formula for deriving the length of the take-off run, proposed by the author earlier, was now modified, taking into account aerodynamic relief. An equation of the polar curve for an aircraft with mechanization in the take-off position (without leading-edge flaps), based on statistics (wind-tunnel tests of models), was presented. A simple design formula for the optimum aircraft lift coefficient was derived. The graph of optimum aircraft lift coefficients during take-off as a function of the coefficient of resistance to wheel movement for various aircraft lift coefficients at lift-off was presented. It can be seen from the derived formulae that the "maximum-optimum" take-off mode is possible, wherein the maximum aircraft lift coefficient during take-off is equal to the optimum aircraft lift coefficient during take-off, which is in turn equal to the maximum aircraft lift coefficient during lift-off (a "three-point take-off"). The following conclusions were made: optimum aircraft lift coefficients during take-off increase, as forces of resistance to wheel movement on the ground increase; optimum aircraft lift coefficients during take-off increase, as wing mechanization power decreases; effect of aircraft lift coefficients during take-off on the length of take-off run increases, as the values of the coefficient of resistance to wheel movement increases; at very large values of the coefficient of resistance to wheel movement (equal to or more than 0.25), a three-point take-off and lift-off could become feasible. Figure 1, references: 10 Russian.

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CSO: 1861/343

UDC 534.1:539.3

AIRCRAFT DYNAMIC RESPONSE CALCULATION BASED ON DISCRETE-CONTINUAL MODEL

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 4, Oct-Dec 85 (manuscript received 26 Mar 85) pp 16-20

[Article by M.B. Vakhitov, A.S. Safonov and I.A. Kuznetsov]

[Abstract] In an earlier work by the authors, a numerical procedure was presented for determination of stresses and deformations in cantilevered thin-wall aircraft lifting surfaces, such as a wing or empennage, under a varying in time load, using a discrete-continual model. Now the procedure was generalized, so one could take into account motion of the structure in the aircraft systems as a whole. It was assumed that the aircraft was located in a subsonic compressible flow. Equations of its perturbed motion were derived, only taking into account deformations of its lifting surfaces (there can be several of them). External non-stationary aerodynamic loads on deformable lifting surfaces and on a non-deformable aircraft body were determined, using the discrete vortex method. The set of equations for deriving parameters of dynamic stress-strain state of aircraft lifting surfaces, of displacements of an aircraft as a whole and of a non-stationary dynamic load consisted of three groups of equations, describing dynamic reaction of an aircraft. Initial conditions for solving these equations were presented. The set of equations is interrelated; due to complexity of relations that are part of the set it can only be solved using numerical methods. The solution was constructed with the help of the international "time layers" procedure. According to this method, an implicit differencing scheme was used for solving an elastic problem at each time-step. The use of this scheme made it possible to study behavior of the structure over long time intervals without introducing restrictions on the number of steps in time. The proposed numerical method for calculation of dynamic reaction of an aircraft with elastic lifting surfaces that moves in a non-stationary subsonic flow was realized as software in the FORTRAN-IV language on a YeS-series computer. Model and actual structures were studied. For illustration purposes, some study results were presented. Figures 3, references: 7 Russian.

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UDC 629.735.33.01

EFFECT OF PERMISSIBLE VARIATIONS OF CENTER-OF-GRAVITY LOCATIONS OF CARGO AIRPLANE ON ITS MASS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 19 Mar) pp 24-28

[Article by V.P. Gogolin]

[Abstract] In order to meet requirements for stability and controllability and for the operational range of center of gravity locations, parameters of horizontal tail surfaces that determine the aft and forward limits of center-of-gravity location were chosen. At chosen parameters of the shape of airplane components, the permissible range of variations of operational center-of-gravity locations determined relationships between empennage and wing dimensions. It was assumed that the aft limit of center-of- gravity locations was realized in cruising, whereas the forward limit was realized in take-off and landing modes. If it is possible to narrow the range of operational center-of-gravity locations by means of design changes that require expenditures of mass (for instance, install a fuel tank in the tail fin), the problem of determining the maximum permissible value of these expenditures comes up. This problem was solved, based on the concept of coefficients of increase of airplane mass. The derived solution was applied to a hypothetical airplane, similar, as far as its characteristics were concerned, to the TU-134 airplane. It was suggested that the derived formulae could be used for solving the problem of determining maximum mass expenditures in order to decrease pitch stability of an airplane. References: 4 Russian.

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CSO: 1861/343

UDC 629.7.024.001.5

AIRCRAFT CLASSIFICATION BY TYPE OF PROPULSIVE DEVICES. DETERMINATION OF TYPE AND NUMBER OF CARRYING SOLUTIONS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 3 Sep 84) pp 33-39

[Article by M.A. Guryanov]

[Abstract] The objective of the work was to trace qualitative development (development of types) of aircraft population and demonstrate that in order to convert this development into a purposeful creative process it is sufficient to derive laws of formation of known kinds and types of aircraft, using the dialectic epistemology method and well studied processes of formation of populations of substances, plants and animlas. It was proposed to present the process of forming a population and determining laws of development thereof in the following form: accumulate experience; identify essential features of accumulated elements; determine the type and number m of carriers of these essential features; determine the number of all combinations of m carriers taken n at a time, n = 1, 2, ..., m; based on the number of all possible combinations, conduct creative search for the type and number of feasible combinations - carrying solutions that form known and new elements of the population; form a population, consisting of known and new elements, which is a natural classification by essential features; derive laws of population development. This approach to studying a population simplifies classification and makes it possible not to miss any carrying solution. In this case, the process of searching for new aircraft types (inventions) is still creative, however it is not "random" anymore, but is rather streamlined along clear "rays" - carrying solutions. Types of propulsive devices were identified as essential features of aircraft. A natural classification (ordering) of the population of the most widely used propulsive devices (26 groups of types of propulsive devices that belong to five classical families) was proposed. It was suggested that new types of jet propulsive devices could be developed by, for instance, making considerable quantitative changes of essential characteristics of known propulsive devices, or by significant changes of their shape, or by organizing force interactions between propulsive devices. Determination of carriers of essential features of other types of propulsive devices warranted special consideration. Two more groups were added to the classification, thus

bringing the number of groups to 28 and the number of possible combinations to 268,435,455. Out of these, eight feasible families with 17 principal type groups were identified. The proposed method makes it possible to constantly monitor development of aircraft populations and propulsive devices therefore in time, determine all carrying solutions and quickly start a purposeful search for qualitatively new solutions (inventions). Figures 3, references 6: 5 Russian, 1 Western.

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CSO: 1861/343

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LOCAL-OPTIMAL CONTROL IN SYSTEMS WITH DELAY

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA
in Russian No 4, Oct-Dec 85 (manuscript received 26 Mar 85) pp 39-42

[Article by G.L. Degtyaryov and S.A. Terentyev]

[Abstract] The problem of determining parameters of the control mechanism in aircraft stabilization systems with delay that develops in measuring and servosystems is one of the most important problems in developing control systems of modern aircraft. Optimum control was sought as a function of current and previous measurements of the state of the system. Results, obtained earlier, were expanded. Equations for simulating aircraft movement and for optimum control were proposed. An equation of system motion was derived. Based on condition of local optimality, a set of equations for determination of controller coefficients was derived. Solving the set makes it possible to derive the sought optimal parameters. References: 4 Russian.

12770/9835
CSO: 1861/343

UDC 551.49:621.039

METHOD OF STUDYING HEAT CONDITIONS OF GEOLOGIC ENVIRONMENT IN REGIONS NEAR NUCLEAR POWER FACILITIES

Moscow RAZVEDKA I OKHRANA NEDR in Russian No 11, Nov 86 pp 35-39

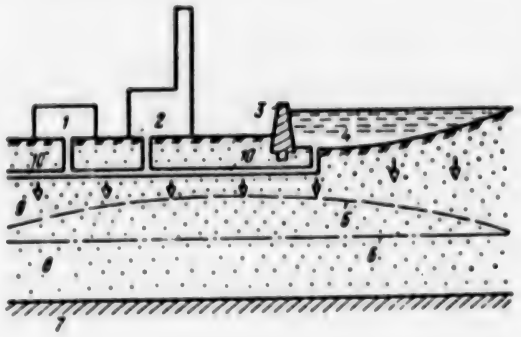
[Article by Ye.A. Yakovlev from UkSSR Minergo]

[Text] The resolutions of the 27th session of the CPSU specified the construction of nuclear power facilities [AEO] as the leading direction in power engineering in the USSR for the future. Nuclear power plants [AES], nuclear heat and power stations [ATETs], and heat supply stations [AST] are distinguished by their complex effect on the parameters of the environment. Discharged heat, which constitutes up to 70 percent of the entry liberated, is one of the main factors in the effect of AEO on the geologic environment [5]. The high heat capacity of water is responsible for its use as the main water-cooling component in the system AEO-production engineering water supply network. The infiltration of leaks of heated technologic waters (up to 50°C) into the underground hydrosphere disturbs the temperature equilibrium in the water-rock system (Figure 1). The warming effect of buildings, pavement, etc., is an additional factor in the increase in the temperature of soils and groundwaters. Thus the operation of an AEO complex results in the formation of a technogenic heat field, which will have to be monitored in order to correctly locate AEOs and accurately predict their impact on the geological environment.

This article examines the generalized hydrothermal impact of only the main water and heat facilities of AEO, including the thermal area where the reactor units, cooling pond (cooling towers), and adjacent area of convective heat transfer, which frequently correlates with the area of the technogenic rise in the groundwater level, are located. Geohydrothermal observations were conducted on a network of wells with a grouped profile that were arranged transversely and along the direction of the ground flow. The length of each of the profiles (ranges) was 1 km, with six to eight wells at a distance of 25 to 200 m apart located in it. Measurements were taken six times a year with double observations in the high- and low-water periods. Data on the empirical change in the heat conditions of the geological environment were processed on the methodological base of hydrofiltration [6] since convective heat transfer (values of the heat capacity of water are significantly higher than that of the mineral skeleton) predominates in an AEO-geologic environment system. The analysis of the heat transfer conditions in the system under

study showed that a number of hydrogeologic and engineering factors facilitate the active development of these conditions during the construction and operation process. These are as follows: 1) significant depth of water-cooling facilities, 2) technogenic intensification of the infiltration feeding of groundwaters when a lateral runoff that is accompanied by a rise in groundwater level and filtration speed predominate, and 3) an increase in water consumption compared with that by other power-generating facilities (2 m^3/s versus 1.1 m^3/s at conventional heat and power stations [TETs]).

Figure 1. Schematic of the geohydrothermal conditions of AES.



Key:

1. Production buildings of AES
2. Reactor unit
3. Water-cooling pond dam
4. Water-cooling pond
5. Technogenic groundwater level
6. Natural groundwater level
7. Ground-level water-confining soil
8. Sandy loam foundation soils
9. Entrance of technogenic waters and heat
10. Production water and steam lines

The development of quatitative methods for forecasting the heat and water transfer in the AEO-geologic environment system is of great practical interest in the context of the necessity of selecting optimal versions of configuring AEO. The heat liberation of an AES with a capacity of 4,000 MW in a sanitation and containment region with an area of up to 30 km^2 exceeds the heat transfer parameters of the environment 1.5- to twofold (the mean multiyear balance atmospheric heat liberations in a natural mode are 8×10^6 kJ/m^2), which confirms the significant techogenic changes in the natural temperature fields in the upper region of the AEO-geologic environment system.

To completely evaluate the geologic and ecological effect of the heat liberation of AEO and to discover their interconnection with changes in the geologic environment, we will compare the natural atmosphere W_{atm} and deep W_E heat transfer for the area of the Central Russian plateau [1, 6].

$$\frac{W_{atm}}{W_E} \simeq \frac{8 \times 10^6 \text{ kJ/m}^2\text{.year}}{1.6 \times 10^3 \text{ kJ/m}^2\text{·year}} \simeq 5000 \qquad (1)$$

The results of these computations show that the predominant entry of technogenic heat from AEO into the system groundwater-mineral skeleton may become the cause of a significant change in the temperature conditions of the geologic environment and may have a noticeable effect on the state of the groundwater in the foundation of their supporting structures.

Data on the technogenic heat field of AEO are reflected in the schematic of the ground-level geohydroisothermal curve (Figure 2) and the geohydrothermal profile plotted according to the range of the hydrogeological wells (Figure 3, Table).

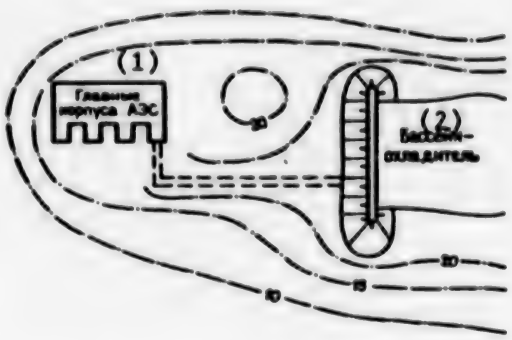


Figure 2. Schematic of the isothermal curve of the groundwaters in the region of the location of an AES

Key:

1. Main building of AES
2. Water-cooling pond

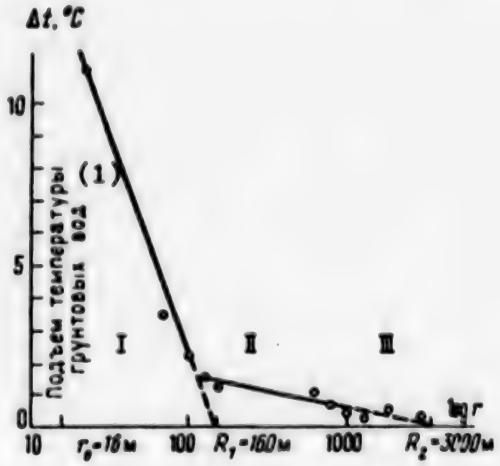


Figure 3. Geohydrothermal profile of groundwaters in the area of the effect of heating by facilities at an AES

Key:

1. Rise in groundwater temperature

Table.

Well	Distance From Object Generating Heat	Heating of Groundwater, t °C
1	25	11.0
2	75	3.5
3	100	2.2
4	125	1.5
5	150	1.2
6	650	1.0
7	750	0.7
8	1,000	0.5

The simultaneous analysis of these data makes it possible to note the following regular connections of the technogenic heat field of the system AEO-geologic environment:

1. High groundwater temperatures are established in the area of the water-cooling pond and production area.

2. The heating of the groundwaters in the vicinity of their transit motion is relatively even.

3. The field of the stable increase in temperature of the groundwaters from the outer loop of the production area to the area of the natural motion of the ground flow (the area of convective heat transfer) is close to planar radial.

4. A close connection between the conditions of the development of a heat field with the geofiltration parameters of the underlying rocks, which is manifested in the descending nature of the change in the level and temperature gradients, is noted.

5. The increase in goundwater temperature is close to quasisteady (in time), which attests to the stable nature of the water and heat transfer and accompanying changes in the temperature conditions of the upper region of the lithosphere.

To estimate the heat transfer parameters in the technogenic heat field, the author processed data about the groundwater level and temperature, computing the thermal balance on the basis of maps of the geohydroisothermal curve (see Figure 2) and plotting semi-logarithmic graphs of the rise in temperatures $t^\circ = f \log r$ (see Figure 3), which are analogous to those used when monitoring depressions in water intakes [2, 6]. Some increase in temperatures in the upper strata of the geologic environment due to the effect of conductive heating of the soil by the structures of the AEO was ignored since the thermophysical properties of the soils (heat capacity and heat conduction) are significantly lower than analogous parameters of the groundwater flow [1]. The substantial predominance of convective heat transfer in the planar-radial flow with its insignificantly conductive dispersion upon a reduction of the groundwater level below the depth of the seasonal temperature fluctuation (see Figure 3) is the main factor determining the possibility of using the function presented. An analogous conclusion about the insignificant effect of seasonal temperature changes on the technogenic groundwater conditions was obtained previously during a study of the geohydrothermal conditions of the industrial park of a TETs, which is distinguished by significantly lesser volumes of water and heat transfer compared with that in an AES [3].

In the graph of the function $t^\circ = f \log r$ (see Figure 3) it is possible to single out three areas with distinctive heat transfer conditions:

I. An internal region, which is virtually bounded by the dimensions of the heat-liberating objects and which is characterized by an intensive entry of warm technogenic waters with a simultaneous rise in level and accelerated cooling of the groundwaters lying in the band of seasonal temperature fluctuations, i.e., the region of the maximal geohydrothermal gradient [3];

II. A central region having a planar-radial stratum "piston" motion of the groundwaters that encompasses the main part of the heat field of the AEO-geologic environment system; and

III. An outer region with an unstable heat field behavior that is distinguished by a variability in groundwater temperature within a range that is close to the background range.

The extrapolation of linear sections of the graphs $t° = f \log r$ in the I and II strata to their intersection with the r axis is of interest in making practical estimates and computations. The values R_1 and R_2 obtained thereby (see Figure 3) may be interpreted as radii of the separated geohydrothermal of the technogenic heat field of the system AEO-geologic environment. These are distinguished by their hydrothermal conditions. The values R_1 and R_2 (160 and 3,000 m respectively) attest convincingly to the fact that the main regularities in the development of the hydrogeothermal field appear in the II band where the determinant effect belongs to the convective transfer of water and heat. It has been proposed that a computation of the mean increase in the temperature of the ground flow in the bounds of the thermal regressions of the I and II strata using an equation for computing the mean decrease in the level in the range of the depression be used to increase the accuracy of estimating the amount of heat entering the system from the ground flow [7]:

$$S_{cp.} = 0{,}217 S_0 / \lg(R/r_0), \tag{2}$$

Note: subscript "cp" in equations 2 to 4 = mean.

where S_0 is the reduction in the level in the completed well and R and r_0 are the respective radii of the depression and water intake part of the well filter.

Then, by analogy with (2), the respective weighted mean increases in groundwater temperature in the I and II strata are

$$t^{\circ}_{I_{cp}} = 0{,}217 t^{\circ}_I / \lg(R_1/r_0) = 0{,}217 \times \times 11/\lg(160/16) = 2{,}4°, \tag{3}$$

$$t^{\circ}_{II_{cp}} = 0{,}217 \cdot t^{\circ}_{II} / \lg(R_2/R_1) = 0{,}217 \times \times 1{,}5/\lg(3000/160) = 0{,}27°. \tag{4}$$

In the context of the great duration of the functioning of the geotechnic AEO-geologic environment system (up to 30 years or more), the data obtained when solving functions (3) and (4) are of practical interest for the quantitative comparison of natural and technogenic heat flows. The solution of a steady-state convective heat transfer by a groundwater flow with a planar-radial form is used to schematicize the computations somewhat.

The estimation of the increase in the heat content of the groundwater flow in the I and II gechydrothermal strata at $t^{0}_{I_{mean}}$ and $t^{0}_{I_{mean}}$ and their comparison with the Earth's natural heat flow (W_E = 1,000 kJ/m² x year) were carried out according to the following simplified function:

$$W_1 = \pi (R_1^2 - r_0^2) h n \lambda, \tag{5}$$

$$W_2 = \pi (R_2^2 - R_1^2) h n \lambda, \tag{6}$$

where h is the ground-level force, n is the active porosity of the rocks, and A is the heat capacity of the water.

The estimates derived on the basis of functions (5) and (6) attest to the fact that the technogenic influx of heat in the I strata isseveral times higher than the natural, and in the II band it is 50 to 10 percent of the natural.

It is very difficult to obtain strict heat transfer solutions in the AEO-geologic environment system because of the extreme complexity of the bounding surfaces of the heat-carrying objects and the change in the thermophysical characteristics of the objects in the process of their operation and the necessity of allowing for the phase transitions of the waters and rocks. Therefore, to obtain an engineering solution to similar types of problems, it is expedient to use simplified computation schemes and models that make an allowance for the analytical closeness of the equations describing the thermal, electrical, and geofiltration processes.

Estimates of the natural and technogenic geohydrothermal fields in the vicinity of the influence of AEO indicate a significant increase in the water and heat transfer and heat content of the geologic environment, which may be the reason for such thermogeomechanical processes as the following: reduction in the bearing capacity of the strength characteristics of the mineral ores as a consequence of their leaching and an increase in the total porosity of the rock mass, manifestation of temperature stresses accompanied by swelling, contact shifts in foundation rocks, etc. An intensification of the processes caused by the interaction of the mineral skeleton with the heated water (high mobility of the water and lesser strength of connections of the soil with the skeleton) are also observed. According to estimates done by the Geological Institute [GIN] of the USSR Academy of Sciences [4], the weakening of the mineral skeleton of lime and gypsum rocks subjected to the effect of heated waters containing free carbonic acid are manifested most intensely. Increased technogenic feeding of the groundwaters and their weak protection against surface contamination may facilitate the active occurrence of the specified processes.

When the temperature increases at the foundation of the AEO at the contact of the bearing structures and the soil, there may occur temperature stresses whose maximal values may be expected at the sites of the greatest drop in temperature and during a high-water rise in temperatures. The early discovery of such strata in conjunction with an estimation of the parameters of the technogenic geohydrothermal field of AEO can ensure the effective regulation of its temperature conditions and prevent temperature stresses. They may be roughly estimated by the following well-known formula:

$$\delta_t = \alpha_t E t_t^0 / (1-\nu), \tag{7}$$

where α_t is the temperature deformation factor, E is the elasticity modulus, t_t^0 is the drop in temperature for the time τ, and ν is the Poisson coefficient.

Despite the significant number of works studying the geotechnic AEO-geologic environment system research on the changes in the hydrothermal conditions

in the region of the effect of AEO and their connection with the technogenic development of exogenous geologic processes is practically nonexistent at the present time. The position that has been taken on the specified problem has been caused, above all, by the limitation of data from long-term observations of water and heat transfer and the absence of a method for complex scientific, production, and experimental works.

The results of full-scale research on water and heat transfer in the vicinity of the effect of an AEO that have been presented are of a preliminary nature; however, the following conclusions may be stated on their basis:

1. A connection between the parameters of heat and water transfer with geofiltration parameters and groundwater conditions has been established.

2. A band structure of the temperature field of the AEO-geologic environment system has been discovered in the region of the groundwater flow.

3. A method has been proposed for computing and comparing the parameters of natural and technogenic heat transfer and the heat content in the AEO-geologic environment system. The use of this method has made it possible to determine the leading effect of AEO on the shift in the temperature equilibrium of the geological environment.

4. The fundamental possibility of the formation of thermomechanical stresses in the linear structures of the industrial parks of AEO located in technogenic heat fields with an uneven temperature distribution.

The research conducted attests to the practical importance of organizing advance observations of heat and water transfer processes and of their regional effect on geohydrothermal conditions and on the development of erosion geologic processes. The results of similar joint research of the subdivisions of various ministries and the USSR Academy of Sciences may, in the future, become the basis of improving geologic engineering regionalization for purposes of optimal arrangement of AEO with an allowance for the thermophysical parameters of the field environment.

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CONSTRUCTION OF NUCLEAR POWER PLANTS DISCUSSED

Moscow NOVOYE V ZHIZNI, NAUKE, TEKHNIKE: SERIYA TEKHNIKA in Russian No 1, Jan 86 pp 51-57

[Report on "Znaniye" publishers' interview with Rem Germanovich Khenokh, director of the construction administration of Zaporozhye Nuclear Power Plant, date and place of interview not given: "We Know How to Build Nuclear Power Plants"]

[Text] [Question] Rem Germanovich, you used to build large thermal electric power plants and now you are building a nuclear power plant. Is there any difference between building a nuclear electric power plant and a conventional one?

[Answer] Yes, there is. It is in the complexity of the structural part, complexity of safety systems, which is quite natural for nuclear power plants, and much greater volumes of jobs on automation and various shielding devices. Structural differences are so substantial that it makes it necessary to change the overall approach and the entire process of construction.

The main difference in the construction of an atomic power plant is a large volume of jobs for each installed kilowatt of power. During the construction of such a large thermal plant as Zaporozhye GRES [State Regional Electric Power Plant], it was sufficient to place 300-400 cubic meters of concrete a day, while at the nuclear plant, we place about 1,000 cubic meters of concrete daily. The volumes of precast reinforced concrete also increased. There appeared a large volume of installation jobs on special structural parts. The quantitative growth dialectically leads to qualitative changes. There appear new specializations in construction. For example, it was necessary to create a subdivision (two administrations!) of assemblers of special structural parts. The total volume of their jobs amounts to more than 2.5 million rubles a month. There was nothing similar during the construction of a GRES. However, it is true that the volumes of jobs at thermal plants under construction now have also increased. However, if we compare the annual volume of construction and installation jobs at the Zaporozhye GRES and AES [nuclear electric power plants], then the ratio is one to two: 60 and 120 million rubles.

The nature of this construction job leaves a definite psychological imprint on the AES builders themselves. It is not because our project is more important than any other or that it symbolizes the present century and the next century.

The point is that the technology itself changes the way of thinking of the modren worker. The considerably greater volume of complex one-piece cast structures called into being entirely new processes. For example, we have to organize a specialized subdivision for mechanized pouring of concrete by means of concrete pumps. This is something entirely new for builders of thermal power plants, even for experienced workers.

Most of the structures at thermal power plants are standardized. They can be produced by any plants according to the existing GOST [All-Union State Standards]. However, nuclear plants require individualized and nonstandard designs. For this purpose, a necessary plant was built.

[Question] Is this, probably, a temporary situation?

[Answer] Of course, partially temporary. Some parts of the structures will be standardized some day and will be produced by central plants. However, for various reasons, it will be necessary for a long time to manufacture some units at the construction site, to smooth out the discrepancies between the design, the supplied equipment and accessories. For example, due to the fact that the fittings of the compensator of the second unit were replaced, we had to order additionally 70 tons of small shaped pieces.

It became possible for us to manufacture all the necessary additional components due to a special construction combine [workshop] which we built ourselves. Today, it has a very important role in our construction project. When it starts operating to its full capacity, it will be possible to improve labor productivity and the quality of work. It must be said that the technological design of this combine has been developed only recently. We were building it purely intuitively. Nobody knew yet the real technology. Now, there is a technological design, and we order nonstandard equipment in accordance with it. We hoped to put the combine into full operation in 1986.

[Question] What distinguishes the Zaporozhye AES from the existing nuclear plants?

[Answer] The first unit of the Zaporozhye AES can hardly be considered unique. Relatively few changes were made in the reactor unit in comparison with previously built AES; only the structural part was changed. The basic principles and the reactor unit itself have already been tested. Before we started it up, identical units were put into operation at the Kalinin AES and South Ukraine AES, therefore, in principle, it can be considered to be standarized to a certain degree.

The project on which we are working provides for the construction of separate power units, or the so-called monoblocks, unlike the design where several units are located under one roof. Evidently, this is what will be used in the future. It justifies itself also from the viewpoint of construction and in operation. Here, it is easier to use mechanical devices and its safety is much higher. This design is probably more technologically efficient. This is, probably, all that has to do with the operating AES.

I think that we have some experience with respect to the AES being built which can be useful for other nuclear power construction sites. Briefly, it can be summarized as follows. Firstly, reactor sections are constructed from large construction units weighing up to 200 tons and mostly finished in-shop. We attempted to use the methods of assemblers of boiler units of thermal electric power plants for buildings and structures; the methods are well-developed and time-tested. Their essence is that the units were enlarged to considerable dimensions and then these large units were assembled at the construction sites. We are doing the same with the construction of buildings for the reactor units and special buildings. Under plant conditions or special installation sites, we assemble units weighing up to 200 tons equipped with all elements. Then we build the "tower" of the nuclear reactor from these 200-ton blocks.

The engineering headquarters of the construction sites is working on further expansion and increase in the size of the structural blocks. We are seriously thinking of creating integrated units of construction structures and equipment elements.

Our other innovation is the development of the techniques of erecting complex structures of one-piece cast reinforced concrete on the basis of reinforced-concrete higher-accuracy formwork, which includes the transportation and pouring of concrete with concrete pumps.

And the third measure which should, probably, be mentioned is the organization of flow-line production in the construction of frequently built structures. This opened up the possibility for a wide use of the brigade-contract method and, chiefly, section-contract method.

All this made it possible for us, starting in 1980, to build and complete two main buildings and ensure yearly construction of one building for a million-kilowatt unit.

[Question] When you mentioned the possibilities of increasing the sizes of the blocks, I should probably remind you that your construction site has a super-powerful crane which other construction sites do not have.

[Answer] Thanks to our crane, we can assemble blocks weighing up to 200 tons. However, the main thing is the principle. If we had 100-ton cranes, we could have assembled 100-ton blocks. A crane could make the task easier or more complicated, however, the principle remains the same. We are quite satisfied both by the big crane, and other mechanization facilities which we have. But to have the equipment is not everything. We experiment with each block: we change the scheme of mechanization, add something, rearrange something. At the present time, we add smaller cranes to the operating large ones. This relieves powerful devices of unproductive "small" jobs. This is not a simple matter. For example, we are changing the mechanization scheme for the third time on the No 3 unit; it is possible that we will not stop with it. We are looking for a scheme which would satisfy all requirements. So far, we have not found one.

[Question] In your opinion, what determines the achievement of the required quality: raising the level of skills of the workers, improvement of the quality control system, or something else?

[Answer] Quality requirements for nuclear power plants and jobs done there are considerably higher, since nuclear safety makes it necessary to use special measures. This, of course, entails changes in the types of structures and changes in the methods of control. For example, we have a specially created inspection unit which monitors all main processes, which is in addition to the usual control services of the clients existing at any construction site. Moreover, we have a differentiated job evaluation system for working teams which evaluates the quality of their work. Naturally, the system is directly connected with the amounts of bonuses.

Of course, the quality of work can be ensured only when the personnel are highly skilled and conscientious. Control systems can either stimulate the workers (if one does not do something properly, he will have to redo it), or prevent possible omissions. Proper organization of jobs also plays a considerable role in achieving the required quality. For example, we attach much importance to a clear division of construction and installation jobs and start-up jobs, considering that this is the main guarantee of safety and successful start-up.

[Question] We know that you have a well operating ASU [automatic control system] in your management system...

[Answer] I cannot tell whether it operates well or poorly. I can only say that we have an ASU. It is not intended for producing reports. It is performing those functions without which a construction site cannot exist: from wage computations to recording warehouse operations, preparation of various schedules, counting transportation flows, etc. We are still far from the situation when ASU would perform all of the functions it is suppose to perform. There is no limit to that. I assume that sooner or later each administrator of any section will have to use such equipment. For this, he will have to either relearn or to learn anew. Such equipment itself and its potentialities have no limit, just as, let us say, the use of the ability to read and write. None of us can explain precisely why we were taught to read and write: this opens up a path to unlimited possibilities. It is the same situation in this area: the new skill will penetrate various aspects of our activities.

[Question] We heard that you refused the organized recruitment services (orghabor) for the first time. How do you manage with your own labor resources, how do you train the workers for your work?

[Answer] I wouldn't say that we refused something. Unfortunately, organized recruitment does not give us the people we need, and we just dc not insist on it. In our opinion, organized recruitment ceased to be a system ensuring adequate replenishment of workers. The people using its services are not used to work at one place for a long time, therefore, it is ineffective to hire them. They only increase the turnover of workers.

Just as at any construction site, we are experiencing a shortage in labor resources. It is, probably, not as acute as at other places. Firstly, we live in the south of the Ukraine and, secondly, this construction site has a good reputation. For example, in two years we managed to hire almost 9,000 people, who just came on their own. This made it possible for us to resolve the

problem of labor resources to a considerable degree. Of course, some of them do not stay on, but not too many.

We train specialists in our own training combine, which we believe to be good. It trains about 1000 skilled specialists every year for the construction site.

[Question] Probably, the provision of housing and social and personal services amenities plays an important role in retaining them?

[Answer] We overfulfill housing construction plans every year, but still there is a shortage...

[Question] There is still a lot or work at your construction site. The builders themselves, probably, are not yet thinking what will happen when the Zaporozhye AES will start operating at its full capacity, however, the administrators of the construction site are, probably, concerned about it. What is your attitude in this connection to the organization of flow-line construction of AES in this region?

[Answer] Besides the Zaporozhye AES, we were instructed to build the Chigirin AES. We are actively preparing for this job. As soon as our team complete the jobs at the Zaporozhye site, we shall start building the new one. So far, we are working on the design together with the designers.

I think that regional flow-line construction, when the builders move, stage-by-stage, from one construction site to another, is, in principle, a correct solution. It would be a pity to create an outstanding team of workers successfully performing construction jobs in the amount of over 100 million rubles a year and then to lose them by not giving them any jobs later. Therefore, the government's approach is to provide jobs for such a powerful and well-equipped organization. However, what is most important is not to lose the collective experience, that great wealth which we are beginning to appreciate properly only now. What does it mean to start a construction job at a new site with new people? This means for everyone, from the workers and foremen to engineers and administrators, to learn everything anew the hard way.

[Question] How are the relations of the builders and designers developing in the course of construction and what problems do you have there?

[Answer] Firstly, there are always problems with delays of the design specifications... However, the main problem is the instability of design solutions, which has a serious effect on the engineering preparation of the structures. There are constant changes in the details which do not change anything substantially but cause confusion and disorganization. We are working on four units, but we do not have exactly the same drawings for any of them.

On the other hand, the changes which take place at the construction site are taken into consideration with delays. In general, we are working together with the designers well and are trying to solve the arising problems jointly. However, unfortunately, they cannot keep up with us. Construction is progressing faster than corrections are made on paper. They should study more effectively

what is going on at the construction site and make the changes in the design faster.

[Question] At the Zaporozhye Nuclear Plant, the No 1 unit has been put in operation, the construction and installation of the No 2 unit has been completed, and the work on the No 3 unit is progressing in full swing... How do you visualize the further course of construction?

[Answer] In accordance with the resolution on the development of nuclear power engineering, our people have to put into service six power units one million kilowatt each before 1990. This will require construction and installation jobs in the amount of over 450 million rubles. However, these huge volumes do not seem to be particularly complicated today; construction jobs "eat up" 120 million rubles a year, constantly improving the economic indexes. For example, the labor input of the builders and installers has been lowered by 25-30 percent for the No 2 unit. For the No 3 unit, we are also expecting an improvement in the labor and cost indexes, perhaps, not as great as for the No 2 unit, since all obvious sources for improvement have already been exhausted.

Now we know how to build a building for a one million kilowatt unit in 3.5 years; we know that it is necessary to shorten this construction time constantly. We know what to do in order to install the equipment for such a unit in one year or even sooner.

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CSO: 1861/97

UDC 621.165.003.13

STUDY OF ECONOMY OF K-1000-60/1500 KhTZ CARBON INSTALLATION AND 1000 MW POWER UNIT OF SOUTHERN UKRAINIAN NUCLEAR POWER PLANT

Moscow TEPLOENERGETIKA in Russian No 12, Dec 86 pp 10-17

[Article by M.G. Teplitskiy, engineer, Yuzhtekhenegro]

[Abstract] Power generating unit No 1 of the Southern Ukrainian Nuclear Power Plant is the first of a series of 1000 MW single units, and includes a type V-1000 M water-cooled, water-moderated reactor with a thermal power of 3200 MW, four horizontal type PGV-1000 steam generators with steam productivity 1469 t/hr each, and a type K-1000-60/1500 steam turbine, power capacity 1045 MW, speed 25 rps, plus a type TVV-1000-4 UZ electric power generator. This article describes the measurement of the characteristics of this unit in operation. Twenty major experiments were perfomed to determine the heat characteristics at 500-1060 MW, each lasting 40 to 60 minutes at near nominal conditions. The studies showed that the economic characteristics of the turbine are equal to the best achieved by foreign devices. Results were better than the design results. Net power generated was 1083 MW at thermal input power 3200 MW, net efficiency 33.9%. Operation of the unit can be optimized by decreasing the throughput capacity of the flow portion of the high pressure cylinder by 5-7% and investigating the possibility of converting the power unit to operate at slightly lower live steam pressure. Figures 8; references 6: 4 Russian, 2 Western.

6508/9835
CSO: 1861/87

UDC 699.851.002.5:[621.311.25:621.039]

RESONANCE METHOD OF TESTING POWER EQUIPMENT IN NUCLEAR ELECTRIC POWER PLANTS FOR EARTHQUAKE RESISTANCE

Moscow ENERGOMASHINOSTROYENIYE in Russian No 8, Aug 86 pp 37-39

[Article by Kh.D. Chechenov, candidate of technical sciences]

[Abstract] Power equipment in nuclear electric power plants must be tested before and after installation for resistance to earthquakes, because the mounting can generally alter its dynamic characteristics. The method now exmployed, excitation by a single power pulse and measurement of the response, does not yield sufficient information about natural modes and frequencies. The resonance method, using rotary unbalanced-mass vibrators, is preferable. These vibrators, together with controls and recording instruments, can be contained in a single cage serving as mobile laboratory. A set of vibrators is needed for matching machines and structures weighing 0.1-10 t and covering a 1:10 size range with natural frequencies covering the 1-60 Hz range. The design of such a rotary vibrator is based on the differential equation of motion for an excitation -limited "test object - vibrator with unbalanced mass" system. This equation, a nonlinear one, is derived from a system of Lagrange equations in generalized coordinates ϕ,x,z (ϕ- angular coordinate of vibrator rotor, x- linear horizontal coordinate, z- linear vertical coordinate). The resulting equation includes the term $2M_1\ddot{z}x\sin\phi$ (M_1- unbalanced mass), which represents the reaction of the test object on the motion of the vibrator rotor and under certain conditions predetermines self-synchronization of rotors. References 5: all Russian.

2415/9835
CSO: 1861/41

UDC 621.186.3.62-77

ADJUSTMENT OF SPRING-SUSPENDED SUPPORTS FOR STEAM MAINS IN THERMAL ELECTRIC AND NUCLEAR ELECTRIC POWER PLANTS

Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9, Sep 86 pp 40-41

[Article by Engineers G.I. Khatetovskiy and M.D. Li]

[Abstract] The continual increase in unit power output at thermal electric and nuclear electric power plants makes it necessary to provide heavier pipes for the steam. Particularly critical are the steam mains, their larger wall thickness also making them more costly. These pipes run both horizontally and vertically, on spring-suspended supports. Reliability is not completely provided by proper design alone, but requires subsequent adjustment after installation and then during service. This adjustment problem is being tackled by the Moscow Institute of Power Engineering,

TsKII imeni Polzunov [Central Institute of Boilers and Turbines], PO Soyuztekhenergo [All-Union Administration of Power System Engineering], Giprokauchuk State Planning and Scientific Research Institute of the Synthetic-Rubber Industry], and various organizations within Minenergo SSSR [USSR Ministry of Power Engineering]. No single method is universally used for spring-suspension adjustment and, therefore, PO Soyuztekhenergo is studying the problem for the purpose of devising one generally applicable method which will include calibration in accordance with technically sound rules and determination of piping+insulation weights prior to installation. Although use of a computer for design and layout offers obvious advantages, it is recommended that hand calculations and estimates be also relied upon. References 1: Russian.

2415/9835
CSO: 1861/57

BELOYARSK AES TO GET 800 KW FAST NEUTRON REACTOR

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 12 Sep 86 p 2

[Article by S. Sadoshenko: "A Fast Reactor"]

[Text] The manufacture of an 800 Megawatt fast neutron reactor for the Beloyarsk AES has begun at the Atommash plant.

Atommash is sending its products to many nuclear power plants being built in this country and abroad. This year plant workers have sent nuclear engineering products to the Khmelnitskiy and Zaporozhye AES and to the Huragua AES in Cuba. In a few years deliveries will also be addressed to the Beloyarsk AES.

A BN-800 [Fast neutron-800 Megawatt] unit has a long production cycle. For Atommash it is new and unmastered. So far, the Volga-Don workers are still cutting metal, welding pipe and preparing fittings. However, a delegation from the Beloyarsk AES has already arrived at Atommash and signed a contract on collaboration under "workers' relay race" principles.

A. Glazyrin, AES Party Committee secretary, explains, "Our station is a unique testing ground. We received the fast neutron reactor, now Atommash is building the BN-800, the world's most powerful, for us. I think that friendship among our collectives will help accelerate its manufacture and startup."

Fast neutron reactors differ from other ones in that they not only generate electrical energy, but also process secondary fuel, creating plutonium. Thanks to this, the energy output from a ton of natural uranium is increased 20-30 fold. The task during this five-year plan is to organize the development and production of 800 MW power generating units using fast neutron reactors. Atommash has already set about this task.

11574
CSO: 1861/14

UDC 621.311

MHD-ELECTRIC POWER PLANTS, HIGH-TEMPERATURE TECHNOLOGIES AND POWER MACHINE BUILDING

Moscow MASHINOVEDENIYE in Russian No 6, Nov-Dec 86 pp 3-10

[Article by A.Ye. Sheyndlin; article based on a report the author presented at the Joint Meeting of the Department of Mechanics and Control Processes and the Department of Physics Engineering Problems of Power Engineering of the USSR Academy of Sciences on 17 Dec 85]

[Text] The High Temperatures Institute of the USSR Academy of Sciences [IVTAN] has accumulated a great deal of experience in developing technologies from an idea to the creation of new engineering prototypes. Based on a number of technologies that have been created, we will examine some problems whose solution made it necessary to organize a new structure for the institute.

Inasmuch as the technologies examined are all connected in some way with power engineering, the greater portion of the problems that have arisen are connected with power machine building in some way or other. It should be noted at the outset that in many cases we are referring to the necessity of creating a new machine building base, solving quality and reliability problems, and finally, finding new forms of unifying the efforts of science and industry. To establish this, we will pause on several technologies being developed at the IVTAN.

Magnetohydrodynamic [MHD] electric power plants. Throughout the course of the development of power engineering, specialists have sought ways of increasing the effectiveness of converting thermal power to electrical. At the present time, a large portion of electrical power is produced by thermal electric power plants that operate on fossil fuel. The efficiency factor of the best thermal electric power plants only reaches 40 percent, and this cannot be significantly increased in any way. The remaining portion of power is into the environment in the form of heat. Increasing the efficiency factor of electric power plants even 1 percent yields an enormous economic effect. On the scale of our country alone, the fuel savings in a recalculation for equivalent fuel is 3 million tons annually at the same consumption, or in other words, at the same rate of fuel consumption, approximately 10 billion kilowatt hours of additional electrical power would be produced. That is why the ever-increasing interest in searching for new methods of obtaining an increased efficiency factor is natural. In this respect, the method of

directly converting heat into electric power based on the use of the magnetohydrodynamic [MHD] principle is very promising. Intensive operations to create MHD power plants are underway in the IVTAN.

For the past 20 years, the problem of the MHD energy conversion moved from laboratory physics research to testing large, complex model and semi-industrial power plants and making them operational. We have now reached the stage of introducing MHD electric power plants (MGDES) into industrial power engineering. We will briefly examine the operating principle of an MHD generator. If compounds containing alkali elements with a low ionization potential are added to a high-temperature flow of burn-up products, the gas becomes electrically conductive, i.e., it is in a plasma state. With a temperature around 3,000 K and a high speed (approximately 1,000 m/s), such plasma passes along a channel located in a strong magnetic field. Due to the interaction of the moving plasma with the magnetic field, the plasma's kinetic energy is directly converted into electrical energy. This is the first stage of obtaining electric power, where the plasma's temperature is reduced approximately to 2,300 K. Afterward, the gas flow may be used in ordinary steam power plants. This is the second stage of obtaining electrical power.

The first U-02 power plant with an MHD generator was started up in the USSR in 1964. After conducting a large complex of research on this power plant, the Ministry of Power and Electrification of the USSR [Minergo SSSR] and USSR Academy of Sciences began creating a test industrial power plant, the U-25, in the High-Temperatures Institute of the USSR Academy of Sciences. High-temperature air heaters, burn-up chambers, an MHD generator channel, magnetic system, steam generator, and system for inputting and outputting additive, etc., are the most important subassemblies of this power plant. The rated capacity of the MHD generator of the U-25 power plant is 20 MW, attaining a duration of continuous operation of 250 hours. It should be noted that an MHD electric power plant contains large-scale equipment operating under rigid thermal and electrical conditions. Creating such equipment requires specialized production and persons who have mastered such technology as those of electrical engineering and thermomechanical enterprises.

The complex of operations carried out on the MHD power plants of the High-Temperatures Institute created a strong basis for the transition to a new stage in introducing the MHD method into large-scale power engineering. The results of placing the U-25 MHD power plant into operation and studying the distinctive features of the structure of fuel and energy of our country made it possible to determine the sequence for introducing MHD electric power plants into power engineering in the Soviet Union. Initially, it was decided to introduce natural gas-based MGDES where construction of ordinary thermal electric power plants were either being planned or already exist.

At the end of the 1970's, the USSR Minenergo and a number of other organizations in the country under the scientific administration of the High-Temperatures Institute of the USSR Academy of Sciences began developing a main MHD power plant with a capacity of 580 MW that is based on a mixture of gas and fuel oil. Construction of the first industrial MHD power-generating unit (MGDES-580) is currently underway at the Ryazan GRES. An MHD power-generating unit operates in the following manner. A heated oxidizing agent, natural fuel

gas, and an ionizing additive (potash) are placed into the burn-up chamber. The oxidizing agent, atmospheric air or air that has been enriched with oxygen, is fed by compressor into a high-temperature heater in which it is heated to a temperature of 2,000 K, after which it enters the burn-up chamber. The electrically conductive plasma that is formed in the combustion chamer is accelerated in the nozzle to a speed of 1,300 m/s and enters an MHD channel located inside a magnet. The direct electric current arising in the MHD channel is led through the channel's electrode wall, is converted to alternating current in an inverter system, and enters the power system through step-up transformers.

The capacity of the MHD generator of the main MHD power-generating unit is 270 MW; the magnetic system is superconductive with a maximal inductance of 6 teslas. From the MHD channel, the burn-up products enter a diffusor where the speed is reduced and pressure is restored. Afterward, they are fed into a steam boiler. The steam produced in the boiler is used in a steam turbine with a capacity of 312 MW. After the boiler, the impurity is scrubbed from the burn-up products in an electrostatic precipitator. Next, the burn-up products give up their heat to the air in the system of low-temperature heat exchangers and are expelled through a smokestack. The ionizing additive is in turn regenerated and returned to the burn-up chamber. When the MHD generator is switched off, the steam turbine part of the MHD power-generating unit may work autonomously on account of the burn-up of the fuel in the boiler furnace. Combining the modes of joint and autonomous operation expands the range of regulation from 100 to 25 percent of the power-generating unit's capacity.

The fuel savings in a main MHD power-generating unit is approximately 16 percent, and it is 24 percent in a series unit.

Using MHD power-generating units will make it possible to signficantly reduce fuel consumption for production of electric power (in the future, up to 30 percent), reduce toxic emissions into the environment by 25 to 30 percent (per unit of power produced), reduce the need for coolant water 1.5- to twofold, and significantly reduce the unit power of a power-generating unit.

Construction of the first main power-generating unit will be completed at the end of the 1980's. Afterward, analogous MHD power plants with a capacity up to 1,000 MW will be introduced. At the same time, theoretical and experimental research on creating MGDES based on coal fuel, of which the Soviet Union has enormous reserves, is being intensively conducted at the IVTAN. The first coal-based MHD electric power plants will probably appear in our country in the middle of the 1990's.

It should be noted that the MHD method of producing electric power has yet another advantage. The MHD generator is a maneuverable and powerful electrical machine. These properties have given it yet another sphere of use, in geology and geophysics. This accounts for the emergence of the acute need for high-power energy sources that can help stimulate a strong artificial electromagnetic field for deep sounding of the Earth. An MHD generator can help send a strong electromagnetic pulse into the Earth's core. Response signals fixed by receiving stations contain information about the spatial distribution of electrical conduction in geological structures. After

deciphering the information obtained, it will be possible to decide whether useful minerals are present, and a change in the electrical conduction of rocks in time attests to the possible imminence of an earthquake.

Under the direction of academician Ye.P. Kurchatov, work conducted by the Institute of High-Temperatures together with the Atomic Energy Institute imeni I.V. Kurchatov and other organizations has resulted in the development and practical application of deep electromagnetic research on the Pamir, Ural, and Khibiny MHD units, which possess unique characteristics and have no analogues in foreign technology.

The advantages of such MHD generators are reflected most strongly in the "capacity specific gravity" of their design, i.e., the ratio of the aggregate's capacity to its weight. In the 5- to 100-MW range, the ratio of pulsed MHD generators is 0.5 kg/kW, which is virtually 10 times less than in the majority of other power sources.

Such MHD power-generating units give forecasts of the approach of strong earthquakes simultaneously with studying geodynamic processes on a regional scale (in Central Asia, the Urals, the Kola peninsula). The stage of experimental methodological operations for the purpose of directly searching for and mapping oil and gas deposits has been completed successfully.

The Prognoz-1 (capacity, 40 MW; pulse duration, 2 and 7 s; total weight, 40 T) and Pamir-2 (capacity, 16 MW; pulse duration, 2.5 to 10 s; total weight, 25 T) units are located in the IVTAN's proving grounds in Central Asia. The units are located on a pile and include MHD channels, magnetic, excitation, switching, contol, and measuring systems. The units make it possible to "illuminate" to a depth of 20 km and use signals at a distance of 60 km.

The experience accumulated has made it possible to formulate technical requirements for second-generation MHD power-generating units. This will make it possible to significantly increase the specific power characteristics and improve the economic indicators of MHD power-generating units. In particular, it will be possible to provide a marked fuel savings at the same capacity.

The existing pulsed MHD units operate with a high reliability. However, materials and equipment decisions to increase the operating life of such power-generating units on the order of 300 s are required to accomplish many tasks facing the national economy.

Assimilating powerful artificial electromagntic field sources makes it possible to use fundamentally new electrical prospecting methods and to thereby rise to a new level of electrical prospecting in the complex of geophysical methods for researching the Earth's core.

Implementing a program of the MHD power conversion and a number of other tasks requires magnetic fields of 5 to 6 teslas in a large space. Therefore, operations are underway in the IVTAN to research and develop superconductive materials and cables as well as create very large magnetic systems. For example, the superconducting magnetic system of a main MHD power-generating unit will have an operating thermal space with a diameter of 3.5 m and a

length of 24 m. The inductance of the magentic field on the axis of the thermal space will be 6 teslas. The saddle-shaped winding of the magnet will be executed from that developed in the IVTAN by using completely stabilized copper for the conductor that is based on Ni-Ti. The superconductive cable of the winding will weigh approximately 600 tons, and its operating current will be approximately 12.5 kA. The magnet's power structure will be made of special high-alloy steel and will weigh more than 2,000 tons. The winding's operating temperature will correspond to the boiling point of liquid helium (approximately 4.5 K). The operating temperature is maintained with the help of a cryostat with vacuum insulation, whose design was developed by the Kriogenmash Scientific Production Association [NPO].

A superconductive magnetic system that simulates the magnetic system of the MHD power-generating unit at the Ryazan power plant is currently being manufactured at the IVTAN. The thermal space of this system is cylindrical, 1.8 m in diameter, and 12 m long.

To develop the technology for the magnet's winding, a unique winding machine that makes it possible to manufacture large, saddle-shaped windings made of superconductive cable is being designed and manufactured at the IVTAN. Machining attachments providing all the operations of the conductor winding has been developed.

The creation of the model magnetic system at the IVTAN made it possible to solve fundamental problems related to manufacturing the superconductor magnetic system of the MGDES-530. Unfortunately, the problems of developing an industrial technology for winding large superconductive magnets still remain unsolved. It is obvious that with respect to their scale, the problems connected with creating a similar type of device have long since extended beyond the limits of the capabilities of single academic institute.

The work that has been conducted at the institute for a number of years to create effective sources of high-power electrical pulses is closely related to operations dealing with superconductive magnetic systems. Superconductive inductance energy accumulators [SPIN] are one of the most promising types of such sources. A SPIN is capable of storing a very large amount of power in a single unit and storing it virtually without loss for an indefinite time. For example, one of these converts power fr a direct current source with a power of 50 to 100 kW into electrical pulses with a power up to 500 MW. To compare their scales, it is possible to show that 500 MW represents the capacity of a large power-generating unit of a modern electric power plant. Strictly speaking, the superconductive accumulator component represents a sectioned superconductive solenoid whose 12 sections are connected parallel with one another. It is manufactured from a superconductive conductor consisting of 42 combined conductors 0.3 mm in diameter (the six superconductive filaments of their fusion are 0.07 mm in diameter in a copper matrix). The combined conductors are twisted with seven copper ones of the same diameter and are soldered together by a special low-melting high-ohm alloy that prevents the development of eddy currents as the SPIN discharges. The design of the solenoid housing and its winding provide effective cooling on account of the penetration of liquid helium into the inner regions of the winding. The solenoid and current input system have been designed to operate

at electrical voltages exceeding 50 kV.

Other high-voltage technologies. In the field of high-temperature power production processes, the IVTAN has been productively cooperating with such large enterprises as the Cherepovetskiy and Novolipetskiy metallurgical combines for more than 10 years. This cooperation encompasses all the main spheres of metallurgical production, blasting, steel-melting, and rolling.

Based on the experience accumulated during the development of MHD units, the institute proposed using regenerative high-temperature heat exchangers in blasting production in order to significantly raise the temperature level of hot blasting, thereby providing the most significant savings of coke. In the spherical packing of this type of heat exchanger it is possible to implement the high-temperature noncatalytic steam conversion of natural gas (T = 1,800 to 1,900 K) with an output of hot converted reducing gas at a level of 97 percent. Feeding this reducing gas into a blast furnace makes it possible to reduce coke consumption sharply (by 200 to 300 kg per ton of pig iron). Based on the technologies proposed by the IVTAN, installation of high-temperature heat exchangers is currently underway in plants in Tula and Satka. Plans are being formulated together with the Cherepovets Metallurgical Combine to redesign VTVN [high-temperature air heater] units for an increased temperature as well as to introduce processes for the direct reduction of iron from concentrated powder and pellets by using the hot reducing gases produced in the regenerators. Improving the design of blast tuyeres made it possible to increase the blast furnace's operating life two- to threefold with a simultaneous reduction in heat losses.

Making model 2000 rolling mills operational and introducing them on a broad scale during the redesign of heating furnaces was a critical stage in the operations with the Cherepovets and Novolipets metallurgical combines, and in the subsequent phase the critical phase was designing bearing devices for all the other furnaces, furnaces with walking or push-type beams. The proposed decisions made it possible to increase the productivity of the heating furnaces and quality of heating of the slabs significantly and also reduce fuel consumption for heating billets by 10 to 15 percent. The yearly economic effect at the two plants was approximately 15 million rubles.

In the framework of the complex target program, the institute worked together with the Cherepovets combine to create a complex laser production complex for hardening and surface alloying of the rollers of a 2000 rolling mill. An original gas dynamic laser developed at the IVTAN is used as the basis of the complex. Its hot gas (90 percent N, 2 percent H_2O, and 8 percent CO_2) source is the previously mentioned high-temperature air heater with a spherical packing. The laser complex and all of its auxiliary equipment are currently being debugged for the operating parameters under plant conditions, and work on the technology for hardening and surface alloying worker and bearing rollers has begun. The experience of the first stage of these operations is currently being used to develop a plan for series laser production complexes. Using laser technology to help in surface treating metal products (rollers, rail heads, tires for wheels, etc.) make it possible to increase the service span of the treated products four- to sevenfold.

Figure 2

Figure 2

Figure 1 presents a block diagram of the mirror. It consists of a thin reflective copper layer (1), cooled layer (2), and housing (3) that is made either of copper or of stainless steel or titanium. The reflective layer is usually between 0.5 and 1 mm thick. Several ways of producing the cooled layer are possible. Most often, a system based on a single-row brass grid is used, both because it provides high heat extraction coefficients and because of the rather rigid connection of the reflective plate with the housing. Coolant is fed to the layer (2) along channels (4), and is removed through channels (5) in the housing.

Figure 2 shows a section of such a mirror. The grid, inlet and outlet channels for the coolant, and collector system are visible.

Mirrors of this type were recommended as being very reliable in work with well-restorable operating characteristics.

Research on the complex processing and use of fossil fuels with simultaneous solution of ecological problems occupies an important place in the developments at the IVTAN.

A technology for gasifying high-sulfur fuel oils that makes it possible to obtain scrubbed power gas for progressive types of power-generating units with a high efficiency factor and reduce toxic emissions of sulfur oxides into the environment 10-fold, emissions of nitrogen oxides 7- to 10-fold, and volatile ash 100-fold was developed and made operational at the experimental industrial installation of the Azot Production Association in Shchekin in the 1970's. These operations became the basis for the development of the largest installation for gasifying high-sulfur fuel oils in the world at the Dzerzhinsk TETs of the USSR Minenergo. Its productivity with respect to scrubbed gas is 200,000 m^3/hr. Despite the reduction in the portion of fuel oil in power engineering, the problem of preventing toxic emissions when they are burned remains urgent for the long term.

The technology developed may be used in power engineering and the petroleum-processing, petrochemical, and other sectors of industry where liquid boiler fuel is used and also serves as the basis for creating coal gasification technology.

The redesign of the experimental industrial installation for gasifying high-sulfur fuel oils at the Azot Production Association to allow for gasification of coal suspensions was completed in 1983-1984. The installation's productivity was increased to 1 ton coal suspension per hour, and the pressure was increased to 2 MPa. Two complex multiple-day tests of the gasification of fuel oil and coal suspensions were successfully carried out on the installation in 1985. Plans call for making operational in 1986-1987 the technology for gasifying water-and-coal suspensions with the production of scrubbed power gas or syntnetic gas for producing liquid fuel.

Current progress in power engineering and machine building is related to the use of hardware, production processes, and phenomena occurring in construction materials at experimentally high concentrations of power (the effect of high-power lasers; electron, neutron, and plasma flows; high-power shock and detonation waves; high-speed impact; etc.). Unfortunately, information about the thermophysical properties of matter at extremely high pressures and temperatures are currently very limited.

For this reason, complex research on the thermophysical properties of matter and gas dynamic phenomena in materials under the effect of high pressures and temperatures, which have been created with the help of highly intensive pulsed effects, have been begun at the IVTAN. Explosives and electroexplosive propulsion devices, lasers, and electrodynamic acceleration devices, i.e.,

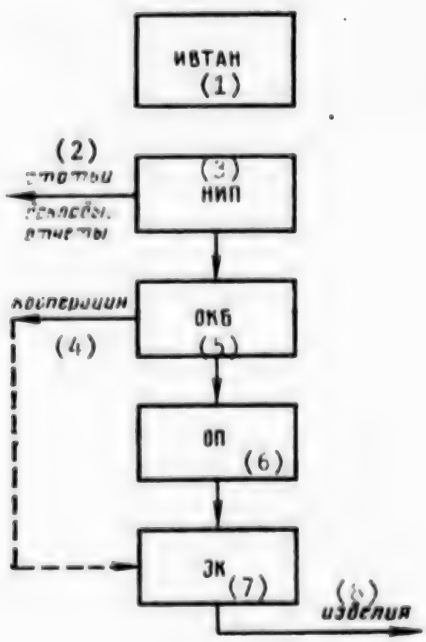
magnetoplasma accelerators, are being used widely for this purpose.

This device implements the conversion of electromagnetic energy from a primary power source (capacitor battery with a current up to 1 MA) into the kinetic energy of a dielectric striker. When the striker decelerates on a target of the material being studied in it, there is a strong shock wave with a pressure amplitude of approximately 1 Mbar. When propagated through the target, the wave causes the compression and irreversible heating of the target.

It is not possible to cover the institute's interesting developments related to automating experimental research, creating equipment for diagnosing the solid state of gas flows, plasma flows, etc., in the framework of this article. These developments make it possible to successfully study the processes occurring in different nodes of the aforementioned technologies and devices.

Organizational forms of conducting operations. In virtually all cases where an idea is implemented at the IVTAN, the indispensible condition of the high quality and reliability of developments results in difficult problems related to organizing the required operation, both in the scientific collective (institute) and in cooperation with industry. A structure that is somewhat unusual for an academic institute has been created to bring large developments and technologies to their completion in the High-Temperatures Institute (Figure 3). The most interesting ideas and scientific developments of the scientific research subdivisions [NIP] of the insitute are "embraced" by the following structural subdivision, a special design office [OKB]. In the OKB, special technical documentation that then enters experimental production for manufacturing the corresponding product is developed based on the ideas of scholars. In a number of cases, outside large enterprises working in cooperation with the IVTAN are brought in for implementation of a development.

Figure 3.



Key:

1. IVTAN
2. Articles, reports, accountability
3. NIP
4. Cooperation
5. OKB
6. Experimental production [OP]
7. Experimental complex [EK]
8. Product

Inasmuch as we are always referring to fundamentally new developments, the task of "bringing" a product (technology) to design parameters is extremely difficult. For this, the IVTAN has yet another structural subdivision, an experimental complex that is equipped with modern research equipment and with specialists who have high engineering qualifications.

A similar structure for the institute has been tested by multiyear practice and appears very convenient and justified, especially considering current problems with the development of scientific-engineering progress.

To accomplish the program of introducing the MHD method of energy conversion into power engineering, the USSR Academy of Sciences and USSR Minenergo have created an Interdepartmental Scientific-Engineering Center [MNTTs], the main base organization of which is the IVTAN. The chief designer for creating an MHD power-generating unit is the center's director.

The center's activity is based on the program adopted by the USSR Academy of Sciences and USSR Minenergo through subdepartmental or structural subdivisions of the center. Material and financial provision of the activity of the subdivisions of the interdepartmental collective has been assigned to the corresponding base organizations. The structure of the MGD-MNTTs may be changed to include organizations of other ministries and departments to present their administration in the established order.

12794
CSO 1861/101

MAGNETOHYDRODYNAMIC POWER UNIT AT THE RYAZAN GRES

Moscow ENERGETIK in Russian No 12, Dec 86, pp 6-8

[Article by A.Ye. Sheyndlin, academy member, and D.F. Protsenko, Candidate of Technical Sciences, Institute of High Temperatures (IVTAN), Soviet Academy of Sciences - Glavenergo]

[Text] The first power-generating unit in the country with a magnetohydrodynamic installation (MHDI) is being constructed at the Ryazan GRES.

The magnetohydrodynamic conversion of energy is one of the trends in the further development of power-generating installations. The increase in their efficiency and the economizing of fuel are achieved due to the increase in the upper temperature of the cycle. The significant advantages of this method are the absence of moving mechanical parts which are found under high-temperature conditions, and also the high temperature on the outlet from the MHD generator. This makes it possible to employ a supercritical steam turbine cycle as the bottoming of a two-stage energy co-generation cycle. This is in contradistinction to the difficulties encountered in steam-gas cycles due to the relatively lower temperatures of combustion products exhausted from a gas turbien

The thermodynamic cycle of the MHDI is the same as in gas turbines: adiabatic compression and expansion in combination with the isobaric admission and discharge of heat (Fig. 1). The difference lies in the fact that the energy of the expanding gas is converted directly into electric energy, generated as a result of the interaction of the conducting gas flow (plasma) which is moving inside the MHD channel perpendicular to the lines of the magnetic field. In conformity with the law of electromagnetic induction the current which is induced in the plasma is discharged into the network through electrodes which are located on the walls of the MHD channel parallel to the lines of the magnetic field.

For the effective operation of the MHD generator (MHDG) the electrical conduction of the working medium (combustion products) should be no less than 3-5 S/m. This is achieved, on the one hand, by the addition to the gas flow of a small amount of an ionizing additive - a substance which contains an alkali metal with a low ionization energy (usually potash K_2CO_3), and, on the other hand, by means of a high temperature of the gas flow (no less than 1930-2030°C). If the temperature is lower the ionization of the additive is not sufficient for attaining the indicated conductivity and the process of energy conversion in the MHDG is terminated.

The magnetohydrodynamic power unit which is being constructed at the Ryazan GRES (Fig. e) is a combined installation, in which a MHDG with a power of 270 MW serves as a superstructure to the K-300-240 steam turbine, developing a power of 312 MW under these conditions. The steam-turbine section of the unit can also operate independently, i.e., with the superstructure shut down, which makes it possible to regulate the power which is supplied to the network in a very wide range (35-100%).

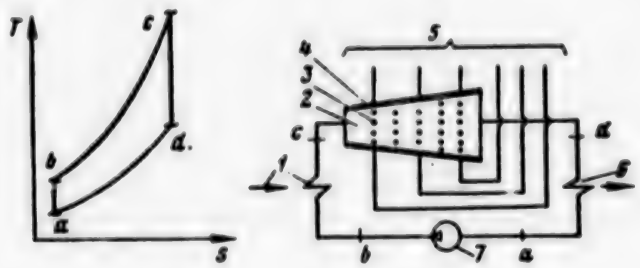


Figure 1. Thermal cycle and layout of the MHD installation:

1 - admission of heat; 2 - MHD generator; 3 - magnetic field; 4 - electrodes; 5 - current leads; 6 - discharge of heat; 7 - compressor; the parameters at points a, b, c, d on the diagram correspond to the parameters in the same points on the TS diagram.

Natural gas will serve as the fuel, and as the oxidizer - atmospheric air or air enriched with oxygen up to 27% by mass. It is assumed that the air will be enriched with oxygen only on the first stage of assimilating the equipment. This will make it possible to master and adjust the MHDG with the calculated parameters of the plasma, without expecting to achieve a stable mode of operation of the high-temperature heaters.

Let us consider the thermal circuit, the parameters and the equipment of the installation.

The gas-dynamic loop. The oxidizer, compressed by the compressor to 1.07 MPa, enters the high-temperature heaters of the blast-furnace type (with heat-retaining packing) and is heated in it up to 1700°C. Further the oxidizer is fed to the combustion chamber, where the fuel and the ionizing additive are also being fed. The combustion products (low-temperature plasma) which are formed in the chamber at the rate of 230 kg/s at a temperature of around 2650°C are fed to the channel of the MHDG, where the conversion of thermal energy into electric energy takes place.

The combustion products which are escaping from the channel are slowed down in the diffuser and enter the boiler with a temperature of around 2000°C at a pressure which is close to atmospheric. In the boiler the heat of these gases generates the steam for the K-300-240 turbine. After removal of the additive the gases are discharged into the atmosphere.

The steam and water loop. This loop of the MHDI is basically the same as the unit with the K-300-240 turbine. The differences which are conditioned by the specifics of the combined installation will be discussed in the consideration of the heat-engineering equipment.

The compressor installation. The oxidizer is compressed in a two-chamber compressor with intermediate cooling between chambers. Under design conditions the productivity of the compressor is 207 kg/s, pressure in the outlet pipe - 1.07 MPa.

Regulation is realized with an input rotating guiding apparatus, and deep regulation - by throttling of air on the input. Each housing has its own drive from a synchronous electric motor with a power of 32 MW. Total power consumption under rated conditions and a temperature of the outer air of 15°C is 64 MW. The use of a compressor with an intermediate cooler lowers the efficiency of the unit somewhat and is a non-optimal solution, accepted on account of simplification of certain structural solutions with respect to the unit.

High-temperature heaters for the oxidizer. Heaters of the blast-furnace type with inherent burners (external heating) are used for heating the oxidizer. The heat-retaining packing in the zone of high temperatures is made from high-purity corundum, ensuring the heating of the oxidizer up to 1700°C; the temperature of the oxidizer at the entrance to the heater (after the compressor) is around 200°C, and the temperature of the flue gases coming out of the heater - 350°C. The further cooling of the flue gases to 130-140°C is realized with air for burning and with the fuel gas, which are heated to 300°C. With such a temperature of the air and fuel the burning temperature is close to 2200°C, which is not permissible with the selected type of refractories. In order to lower the temperature of the flame the flue gases, coming out of the heaters with a temperature of 350°C, are fed into the burning zone with the help of a recirculation exhaust fan.

For preventing the formation of nitrogen oxides in the oxidizer high-temperature heaters, the fuel in them is burned off if there is a shortage (by 2%) of the oxidizer. The decomposition of the oxides which form during their interaction with the products of incomplete combustion and then the oxidation of the combustible components take place in the catalytic reactor which is located beyond the heaters.

The combustion chamber. Under design conditions it has the following characteristics: heat rating 1100 MW, pressure of oxidizer at input 0.9 MPa, plasma consumption 230 kg/s.

The direct-flow type combustion chamber consists of the burning device and the main cylindrical section with a diameter of around 2 m and a length of 2.5 m. These dimensions provide for a time of stay of the working medium in the combustion chamber which is necessary for the vaporization and ionization of the additive - approximately 30 ms.

In order to lessen the concentration of nitrogen oxides in the flue gases the combustion is carried out with a shortage (by 10%) of oxidizer. Subsequently the products of incomplete combustion are burned completely in the steam boiler.

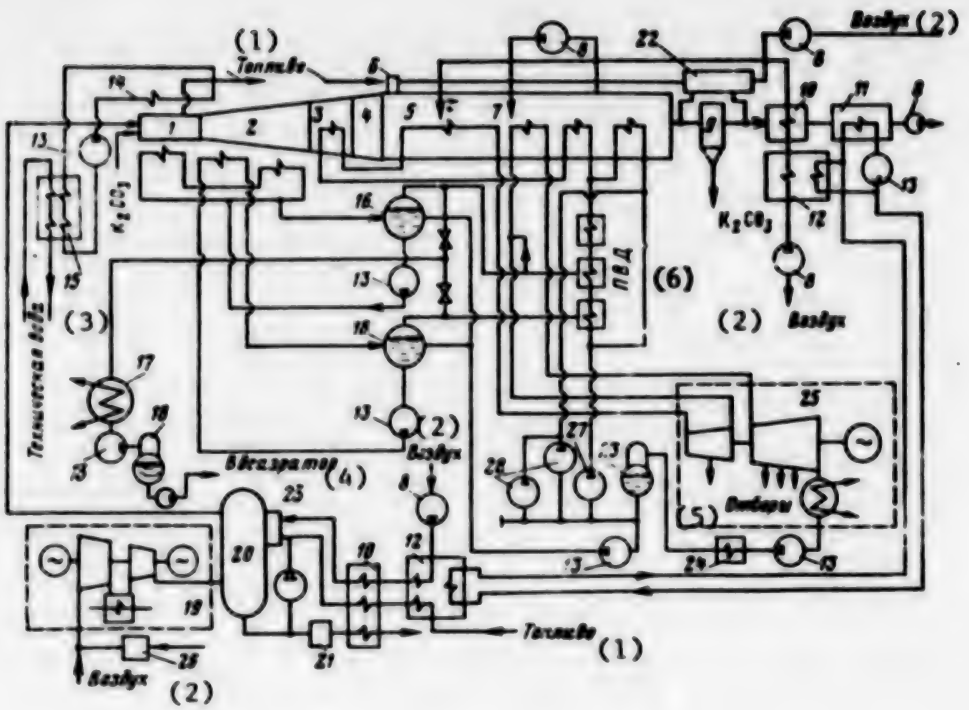


Figure 2. Basic thermal layout of the main MHD generator.

1 - combustion chamber; 2 - MHD generator; 3,4 - water-cooled and ceramic diffusers; 5 - steam generator; 6 - burners for independent operation; 7 - input of air for combustion and recirculation; 8 - exhaust fans; fans; 9 - electric filters; 10 - air preheaters for joint operation; 11 - water preheaters for the heating elements; 13 - pump; 14 - circuit for cooling with nonsteaming water; 15 - water-water heat exchanger; 16 - separating drum; 17 - industrial condenser; 18 - 0.12 MPa deaerator; 19 - double-shaft compressor with intermediate cooling; 20 - independent oxidizer heater; 21 - catalytic reactor; 22 - air preheater for independent operation; 23 - 0.7 MPa deaerator; 24 - group of low pressure preheaters; 25 - steam-turbine installation; 26 - air-separating installation; 27 - feeder turbo-pump; 28 - feeder electric pumps (reserve and emergency).
Key: (1) Fuel; (2) Air; (3) Service water; (4) to deaerator; (5) Bleed-offs; (6) High-pressure heater.

Magnetohydrodynamic generator. The linear conduction generator is a channel of the diagonal type with profile frames, which makes it possible to carry out the individual regulation of current in the frames.

Twenty-four inverters are used in the system for electric charging of the channel. These ensure the optimal distribution of load current along the length. The channel outlet is grounded, and the Hall potential, developing as a result of the interaction of the flow of currents in the MHD channel with the magnetic field, reaches 40 kV on the inlet.

The overall length of the channel is 30 m, including the length of the working sector - 17.5 m. The flow is slowed down to a velocity of 300 m/s in the diffuser and the channel is cooled with water which is circulating inside the frames. In the active space of the channel the superconducting magnetic system creates a transverse magnetic field with an induction of around 5-6 T.

Inverter substation and the issue of electric power to the network. The MHDG and the inverter substation are connected by means of dc cable lines. The load of the MHD channel is distributed over 24 dc circuits with one inverter converter in a circuit. These circuits are formed in 12 units which include a pair of converters and a transformer.

Each unit is switched to one of two sections of collecting buses of a 20 kV indoor switch-gear, where the power of the alternating current of the inverter converters is added together. A power transformer is also hooked up to the buses of this distributing device and through it the power of the MHDG is issued into the network and the current higher harmonic filters.

System for cooling the high-temperature elements. Water is used for cooling the elements of the gas-dynamic loop which are found under the effect of high temperatures. The parameters of the water are selected depending on the conditions of operation and the construction of the cooling elements.

Cooling is realized mainly with steaming water with pressures of 2 and 4.5 MPa. Steam from the steaming-water cooling system is used for heating the feed water in high-pressure heaters No 6 and 7, and under certain conditions a small amount of the 4.5 MPa steam is diverted into the intermediate superheater of the boiler.

The most thermally stressed elements with a complex configuration (flanges, compensators, etc.) are cooled with nonsteaming water with a temperature up to 100°C; the heat is discarded into the service water of the water-to-water heat exchangers.

The products of corrosion and the accumulating salts are removed in installations which are found in each circulation circuit.

Boiler and turbine equipment. The flue gases which are emerging from the channel diffuser with a temperature of around 2000°C enter the input section of the boiler diffuser. The walls of the input section are protected from the effects of the high-temperature flow of gases by shields which are cooled with boiler water which is arriving from the economizer. In the shielded section of the diffuser the gases are cooled down to 1700°C and then are slowed down in the uncooled ceramic section of the diffuser, from which they enter the boiler.

The time that the gases remain in the temperature range of from 2000 to 1700°C is 0.9 s, including 0.43 s in the input assembly. During this time, as a result of the interaction of the products of incomplete combustion, i.e., CO and H_2, with the nitrogen oxides, the concentration of the latter is lowered from 4,000 to 600 ppm; the further decomposition of nitrogen oxides to 350 ppm takes place in the boiler.

The boiler used in the scheme has a number of specific features which are determined by its operation as part of the MHD unit;

in the radiation chamber there is a gas holding zone, where simultaneously with their cooling the decomposition of nitrogen oxides takes place;

the complete combustion of the products of incomplete combustion takes place;

the removal of the additive takes place in the boiler;

provision is made for the mixing of the main flow of gases with a temperature of 950°C and the recirculation flow with a temperature of 340°C for lowering the temperature of the main flow of gases to 800°C; thanks to this the temperature range of 800-950°C, which is particularly dangerous from the point of view of the adhering of the precipitating additive onto the pipes, is eliminated from the heat exchange;

in the boiler the only air that is heated is that which is used for complete combustion, the expenditure of which is 20% from theoretical.

Such an amount of air is not sufficient for cooling the flue gases to the temperature of 130-150°C which is usual for power engineering. In connection with this the flue gases are cooled in the following manner. After the feed pump around 30% of the feed water with a temperature of 170°C enters the primary economizer, where the gases are cooled from 320°C; on the outlet from the main economizer their temperature is lowered to 226°C. Then the gases pass through the electric filter and are cooled with air which had been heated to 90°C for complete combustion.

In the development of the feeding circuit for the boiler the following was taken into account. The walls of the ceramic diffuser, which are made out of MgO, absorb heat from the gas flow and reradiate it onto the shields (wall temperature 1500°C). Even if the entry of combustion products into the boiler ceases, the shields will absorb a heat flux of 120-130 MW, radiated by the walls of the gas input assembly. In order to avoid hot spots in the water wall in this situation the feeding of the boiler even in emergency cases should not be interrupted for more than 60-75 s, and then the flow rate of feed water should be restored at the level of 200-250 t/h.

The following measures, which improve the reliability of the water-feeding installation, are incorporated for satisfying these requirements:

the driving turbine with the counterpressure of the R-12-14P feed pump, operating only jointly with the main turbine, is replaced by a K-17-15P condensing turbine, which can function independently on steam from an outside source; at the same time the use of the condensation drive of the pump improves the thermal efficiency of the turbine by reducing the flow rate of steam through its exhausts, which without this should be somewhat overloaded due to the disconnection of the high-pressure heater;

the admission of feed water from the electric pump directly into the boiler is provided for, which excludes an interruption in feeding in the case of a failure of the high-pressure heater;

an additional emergency electric pump, the PE-380-200 with a power of 3 MW, is installed for the shut-down cooling of the boiler in situations which are out of the ordinary; this pump is turned on in 30-35 s after disconnection of the

regular feed pumps, when the pressure in the boiler is lowered to 22.5 MPa from the run-off of steam through the safety valves which have been forced open;

the reliability of feeding the electric drives of the feed pumps has been increased with back-up station facilities.

These changes in the layout of a turbine plant (use of steam from the cooling system, replacement of the pump driving turbine) caused changes in the flow rate of steam over the turbine stages. Nevertheless no such changes were introduced in the construction of the K-300-240 LMZ turbine, which was stipulated mainly by the flexibility of its structural solutions, and also by the selection of rational conditions of operation.

In conclusion let us remark on the technical and economic indices of the installation.

The industrial-experimental MHD power unit will make it possible to economize around 16% of the fuel in comparison with a steam-turbine unit of the same power, which is less than can be attained on the series-produced MHD installations of the first generation. This is conditioned by the nonoptimal nature of a number of design solutions, which in a number of cases was dictated by the desire to stay away from the development of new equipment. In spite of such an approach, the make-up of the industrial-experimental unit includes a considerable number of unique assemblies, those which required major expenditures for development and for preparation for production. This was relfected in the cost of the equipment and buildings on the whole.

The design developments for the series-produced MHD unit, which are based on the technical solutions described, but included improved equipment for optimization of the layout (use of a compressor with a turbodrive, absence of an intermediate cooler for the compressor, cooling of the channel and the combustion chamber with feed water), showed that such power units will make it possible to economize around an additional 5% of fuel, and all told to reduce the expenditure of fuel by 21% in comparison with steam-turbine GRES. The savings of the calculated expenditures in the case of a cost of 40 rubles/quintal for conditional fuel, are around 7%.

13315
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UDC 622.279.8:658.589

EQUIPMENT FOR FIELD GAS TREATMENT AND TRANSPORTATION

Moscow GAZOVAYA PROMYSHLENNOST in Russian No 3, Mar 86 pp 10-11

[Article by G.K. Zibert, V.A. Tolstov, A.G. Yarmizin and B.S. Yazvenko TsKBN [Central Design Office of the Oil and Gas Industry]]

[Abstract] Along with modular design, complete shipments and increased unit capacity of equipment, developed by TsKBN, a new method for equipment configuration is being developed, unitizing, i.e. combining several production apparatuses in one unit. A unit for absorption gas dehydration with 10×10^6 m^3 per day at 9 MPa pressure is shown and described. Steam heated vacuum regeneration units with 18 m^3/hour capacity are employed for absorbent regeneration. Ten-million gas separators and heaters were developed for UKPG [integrated gas treatment units] for preliminary gas treating and heating before dehydration. Shell-and-tube heat exchangers, operating at 16.0/8.8 MPa pressure, are employed for recuperation of cold in the process of low-temperature separation. Final gas treating is currently performed by mesh separators with fine-dispersed aerosol coagulator. A number of other gas treatment units are also described. TsKBN prepared design documentation for production of unit elements in modular form. New technological equipment was developed for special field conditions. Development of an experimental industrial prototype of a unit for three-stage gas separation is scheduled. New types of separation elements were developed, among them a centrifugal separation element with flow recirculation. New data on operating efficiency of vertical mesh stacks make it possible to develop a new generation of mesh separators that use less metal than separators now in series production. New types of heat exchangers are described. Trends in further improvement of separators and heat exchangers are delineated. Figures 2.

12770
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ON WAYS OF REDUCING CONSTRUCTION TIME OF HYDROELECTRIC POWER STATIONS

Moscow GIDROTEKHNICHESKOYE STROITELSTVO in Russian No 3, Mar 86 pp 1-5

[Article by Candidate of Technical Sciences V.Ya. Shaytanov and Engineer A.G. Yakobson]

[Abstract] It is noted that long construction time of hydraulic power stations is one of the most essential factors that hinder the pace of mastering hydraulic power resources. Despite this fact, actual construction time has increased lately. Examples are presented, showing that whereas in the 1950's it used to take six to eight years to build a large hydraulic power station, which met design target dates, currently it takes up to 12 years for smaller stations, which is 50% more than is specified by design documentation. This reduces construction efficiency and does great harm to national economy. Based on analysis of design documentation and report data on organization of construction of hydraulic power facilities, causes of increased construction time are formulated. Among them are scarce allocation of financial, material and equipment resources; shift of construction to the Eastern part of the country with hostile environmental conditions and to mountain areas with harsh geological conditions; inadequate organization of construction, inadequate level of mechanization, lack of specialized construction equipment; absence of efficient economic incentives for fast completion of construction and cost reduction; stricter environmental protection requirements; increased scope of work on providing required living, cultural and service conditions etc. It is proposed to take the following measures in order to reduce construction time and speed up commissioning of new power plants: improve planning of investments, material and equipment resources, especially at the initial construction stage; improve preparatory period organization; provide construction organizations with modern efficient equipment and vehicles, developed specifically for construction of hydraulic power facilities; expand in Minenergo SSSR [USSR Ministry of Power and Electrification] system production of fast-erectable industrial buildings and residential housing; develop and improve a long-term plan of regional stage construction of hydraulic power stations and development of regional construction industrial bases; improve organizational structure of construction of hydraulic power facilities; develop efficient economic incentives for construction organizations; expand turn-key construction and installation; tighten requirements to meeting planned construction time by all parties involved, including planning bodies and agencies, responsible for material and equipment supplies; develop scientifically justified standards for construction time of hydraulic power stations. References: 6 Russian.

12770
CSO: 1861/257

UDC 66.067.324:628.16.094

DEVELOPMENT AND TESTING OF PROTOTYPE OF CARTRIDGE FILTER WITH 54 t/h CAPACITY

Moscow ENERGOMASHINOSTROYENIYE in Russian No 8, Aug 86 pp 44-46

[Article by V.S. Parykin, candidate of technical sciences, B.P. Pozhidayev, engineer, and S.A. Vlasova, engineer]

[Abstract] A prototype of a new cartridge-type water filter with 54 t/h capacity has been developed, built, and tested at the Zuyevka experimental heating plant. Like the smaller filters of this type now produced at the Chernovtsy chemical equipment manufacturing plant, this filter is a set of vertical thick-walled cylinders made of nitron fiber, viscose, cellulose, wool tailings, and their mixtures pressed together with urea-melamino-formaldehyde resin and phenol alcohol as binder materials. The filter assembly is designed for 0.75 MPa pressure, with an outside diameter of 630 mm and an overall height of 2200 mm. Cartridge cores and caps are made of plain carbon steel coated with epoxy resin to prevent corrosion, all other metal parts are made of corrosion-resistant alloy steel. Water samplers and manometers are installed at the inlet and at the outlet. Water enters from below through a chopper and orifices in a guide disk, flows through the spaces between cartridges, and seeps through their walls while flowing upward. Impurities remain in the cartridges, while the filtrate passes through the central channel into the space under the lid and is there collected for the user. This filter is designed for use with electric dialyzers. The prototype was tested for 1500 h under a pressure drop within the recommended 0.3-0.5 MPa range. It delivered 40-60 t/h, about 1 t/h per cartridge. The pressure drop must be increased, to ensure adequate performance at correspondingly lower capacity, when the water contamination level rises. Analysis of used-up Ts-5 cartridges has revealed that most sulfur, coal, and scrap particles in water stick to the outside surface of cartridges. The filter is also capable of removing colloidal iron and its compounds, corrosion products, and organic matter from water, but ionic iron must be first converted into insoluble compounds and their particles then coagulated into larger lumps. The prototype was also tested with an EKhO-5000x200 electric dialyzer and a UEO-50-4/12.5 apparatus, its performance having been found to be quite satisfactory without extra maintenance. Preliminary tests at the Novocherkassk GRES were performed by V.V. Pyaterikov, candidate of technical sciences, and V.Yu. Lebedev, engineer. Figures 3; tables 2.

2415/9835
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UDC 621.224-131.1:62-755

BALANCING OF ROTORS IN VERTICAL HYDROELECTRIC TURBINE-GENERATOR SETS

Moscow GIDROTEKHNICHESKOYE STROITELSTVO in Russian No 9, Sep 86 pp 16-17

[Article by Engineers V.F. Dolgiy, D.V. Karpovich and V.E. Engel]

[Abstract] Unbalanced rotors, a result of manufacturing or assembly imprecision or of insufficiently stiff mounting, is a most common deficiency and becomes a particularly serious problem in the case of vertical turbine-generator sets. Conventional balancing is done with markers on the shaft, with three test weights, or by the ORGRES method with I001 electrodynamic vibration transducers. Since each method has some drawbacks, especially the ORGRES method requiring a rather difficult prior determination of the transducer phase angle, combining the good features of each is proposed for maximum effectiveness. A permanent magnet and a hermetic contactor are to be used for marking the shaft revolutions. The rotor is driven to run at nominal speed under no load and without excitation, while radial vibrations of the thrust bearing are recorded by a loop oscillograph for determination of their amplitude as well as of the phase difference between transducer output signal at the "heavy" rotor point and speed marker signal. The masses of test weights are determined from experimental calibration curves, whereupon the location of the "heavy" point is determined from these data. A test weight is then moved to the "light" point, which has also been determined in the process. Data on turbine-generator sets in three hydroelectric power plants (Andizhan GES, Gazalkent GES, Toktogul GES) have been used for developing this method of rotor balancing. Figures 3; tables 1; references 1: Russian.

2415/9835
CSO: 1861/55

UDC 621.165.621.3.076.62-77

USE OF SPECIAL MEASURING TECHNIQUE DURING INSTALLATION AND ADJUSTMENT OF REGULATION SYSTEM FOR K-800-240-5 LMZ (LENINGRAD METAL WORKS) TURBINE

Moscow ENERGETICHESKOY STROITELSTVO in Russian No 9, Sep 86 pp 39-40

[Article by Engineers V.I. Fefelov, R.N. Vintilov, N.A. Ponomarev, and S.F. Shchetnikov]

[Abstract] Measurements during installation and adjustment of a regulation system for a K-800-240-5 LMZ (Leningrad Metal Works) turbine cannot yet be made with the aid of the two microcomputers incorporated in the electrical part of such a regulation system, mainly because reliable means of measuring the travel of servomotors are not available. A special technique has therefore been developed which requires use of commerically available devices only. These include digital pressure indicators and transducers with a power supply,

a set of loop oscillographs, and a control module, and instruments for determining the regulation system dead zones and offsets. The transducers are operative whether a regulation system is in a static or dynamic state, each transducer consisting of a tensoresistor as sensing element bonded to a metal membrane with VS-350 adhesive. The indicators operate automatically, driven by signals from a programmer unit which includes a frequency meter connected through a voltage divider to a tachometer generator. The unit operates with 50 Hz, 800 Hz, 3000 Hz voltage at the divider input. The technique of measurements with this equipment facilitates installation and adjustment of a regulation system, but not all operations here can be automated. Among them are the laborious setting of the travel margin available to the servomotor plunger for valve closure, and the laborious measurement of the fluid pressure under the servomotor plunger. The technique is nevertheless applicable not only during start-up but also during routine shutdown for overhaul, during periodic inspection, and for tracking the runner speed during faults. References 2: Russian.

2415/9835
CSO: 1861/57

UDC 621.311.22.002.51.65.011.56

STATUS AND PROSPECTS FOR DEVELOPMENT OF AUTOMATED THERMAL ELECTRIC POWER PLANT POWER UNIT CONTROL SYSTEMS

Moscow TEPLOENERGETIKA in Russian No 10, Oct 86 pp 2-4

[Article by N.I. Davydov and V.D. Mironov, doctors of technical sciences; S.A. Safronnikov, candidate of technical sciences; and A.A. Vinogradov, engineer, Soyuztekhenergo and VTI [All-Union Heat ENgineering Institute imeni F.Ye. Dzerzhinskiy]]

[Abstract] The stages in the development of automated technological process control systems which have occurred since the early 1960s are outlined, culminating in direct digital control by such devices as the R-100 microprocessor regulating controller. Shortcomings in the level of automation of the control of 300 MW and larger power units in thermal electric power plants are mentioned. Further improvements in automation can be achieved by improving the extent to which technological equipment is suited for automation, increasing the reliability of control hardware, decreasing the operating cost of repair and servicing of hardware, further development of software, improvement of the methods of selecting the optimal volume of automation for each installation, creation of conditions for acclerated development of leading models, transition to broader utilization of automated debugging methods, improvement of the organization of the interaction among planners, manufacturing plants producing technological equipment and installers, creation of stimulus for rapid mastery and complete utilization of planned automation levels and improvement of the degree of standardization

of technical devices utilized in automated process control systems. References 9: Russian.

6508/9835
CSO: 1861/68

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STATUS AND PROSPECTS FOR DEVELOPMENT OF MICROPROCESSOR ELECTRIC POWER PLANT CONTROL DEVICES

Moscow TEPLOENERGETIKA in Russian No 10, Oct 86 pp 4-6

[Article by G.G. Iordan, doctor of technical sciences and V.V. Pevzner, candidate of technical sciences, Scientific Research Institute of Heat-Power Instrument Building]

[Abstract] Most thermal electric power plants have no computers at all, because in a centralized control system, computer downtime threatens the stability of the entire controlled system. Since the late 1970s, the principle of distributed control has allowed increasing automation of such power plants, combining the advantages of traditional and automated control. Distributed control is based on three basic principles: the use of digital methods of information processing with small microprocessor controllers; decentralization of control functions and distribution of control hardware throughout a plant; and concentration of control functions and presentation of information within a small information field which can be easily understood. Microprocessor-based controllers include regulators, logical controllers, and display controllers, the operation of each of which is briefly described. All "firmware" for these devices is written by the OEM and burned into the controller's ROM; their hardware components are interchangeable, and thus their functions are mostly differentiated by the firmware itself. Designers are now working on a new generation of controllers based on 16-bit microprocessors, which will significantly increase speed, thus improving self-diagnosis, and system and man-machine interfaces. The production of intelligent sensors with microprocessor information processing is also planned.

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CSO: 1861/68

RYAZAN'S MHD POWER PLANT NEARS STARTUP

Moscow STROITELNAYA GAZETA in Russian 27 Aug 86 p 3

[Article by Ye. Krushelnitskiy: "A Plasma Created by Energy"]

[Text] The next stage in the construction of the world's first magnetohydrodynamic electric power plant (MGDES) is being completed at Ryazan. Its steam turbine system is being prepared for startup.

The idea itself is simple and learned in school: When a conductor passes through a magnetic field an electric current arises. All ordinary generators operate in this way. However, who said that the conductor had to be a solid? The idea still holds true if, instead of a metal wire, ordinary river water is used. As the Earth itself is a huge magnet one can obtain electricity right from the river. About 100 years ago this idea came to the English physicist William Thompson, who, as a result of scientific work was awarded the title Lord Kelvin. He placed a copper plate on each side of the Thames River, attached a galvanometer to a wire connecting them and soon discovered that there was electric current in the circuit.

For a long time this experiment remained only a scientific curiosity. However, it played a role when, in 1962, in a building on Krasnokazarmenaya Street in Moscow, associates at the USSR Academy of Sciences' High Temperatures Laboratory cheered in triumph as a small flashlight bulb was lit. The bulb was ordinary, but the current feeding it was generated by our first MHD [Magnetohydrodynamic] device. The device could be heard throughout the entire street, because in it a stream of plasma rushed at a furious pace.

Since then the small laboratory where this took place has been transformed into the USSR Academy of Sciences' Institute High Temperatures Institute, and the modest installation became the prototype for the MHD power plant in Novomichurinsk. It has the power of modern thermal power generating units. However, this is not the main thing. We no longer have to tolerate the low efficiency of thermal power plants. After all, it is no secret that 60 out of each 100 railroad cars of fuel are burned in vain, producing only smoke and unused heat.

Aleksandr Semenovich Bryskin, chief engineer for the design of the Ryazan MGDES, Moscow Department of the Atomteploelektroproyekt (MOATEP) [Nuclear Heat and Electric Power Design] Institute, says:

"The multistage conversion of energy (thermal - mechanical - electrical) will reach the limits of its potential. It is practically impossible to raise an thermal electric power plant's efficiency factor above 40 percent. An MHD power generating unit, in which heat is converted directly into energy, bypassing a turbine, already has a 44-45 percent factor. In the long term this can be increased to 60 percent. There is also no limit to fuel savings, currently it is about 87 percent. Recall, that thermal electric plants now generate about 80 percent of all energy in the country. This means that each percent saved provides fuel for a GRES the size of the one at Konakovo.

A. Bryskin stresses that MHD stations are not in competition with thermal or nuclear plants. On the contrary, they are intended to supplement one another. After all, the exhaust plasma, having dropped about 500 degrees in the magnetic field, still is more than 2000 degrees. It can then be used in an ordinary steam generator. It is this combination which gives the Ryazan MGDES its 580 Megawatt maximum capacity. However, the steam turbine unit can work autonomously, generating 310 Megawatts. In principle up to 1000 Megawatts could be generated by one unit at such a station. This is twice as much as the prewar Dneproges.

More than a hundred scientific research and design organizations are involved in this work. Scientific work is going directly to the project. Sometimes things must be redone. However, they understand this at the institute, because failures are unavoidable in a complex and little-studied matter such as the creation of a fundamentally new power plant. The path to results must pass through a multitude of problems, both scientific and technical. Take just the plasma. In order to obtain it gas must be heated, using incandescent air as an oxydizer. However, plasma is a capricious creation, impossible to control without deep basic research. Moreover, this hot jet must be accelerated to supersonic speeds. There are many "supers" at the new installation: the magnet, for example, should be a superconductor. It is impossible to do this without superlow temperatures and liquid helium. Huge forces arise in the gigantic magnet, threatening to twist and crush the entire system. These must be confined by special special devices capable of retaining their strength at temperatures close to absolute zero. In short, to build a MGDES means to solve a complicated set of tasks.

The Ryazan Station is helping specialists answer many questions. There are still disputes about how promising the MGDES is. Skeptics have their reasons: equipment here is twice as much as for a TES. The installation is more complicated and operating standards are higher. However, in spite of different positions at times, all are agreed that this firstborn of future power engineering has great practical significance far beyond the station's boundaries. Completely new high temperature heaters, unique highly efficient filters and superpowerful magnets have been created. All these are applicable to contemporary production and will serve science in future research.

V. Burlov, MOATEP director, is confident of success.

He says: "The Ryazan MGDES's startup will be a large step forward in the development of power engineering. The plant will burn a "clean" fuel -- gas. However, the development of such stations will not stop. Today Academician A. Sheyndlin is leading High Temperatures Institute studies on the possibility of creating a coal burning MGDES. There is one indispensible condition here, preventing atmospheric pollution."

The director enthusiastically explains the new installation's advantages. Cooling water consumption is half that of a TES. This is a decisive factor for many regions in the country. It is also important because less damage will be inflicted upon the environment. Effective systems for cleaning combustion products are intended for the MGDES . Nitrogen oxides, for example, will be minimized. However, in addition to chemical pollution, there is also thermal. It too, is markedly reduced, according to preliminary estimates, by half.

An MHD station has an other advantage which should be mentioned: quick startup. The human habit of working days and sleeping nights is a downright misfortune for power engineering. While their might not be enough energy during the day, at night there are surpluses. How can this be redistributed? The best work regime for any generator is an even load, frequent stops are harmful. However, this is not always possible. If a steam turbine is started up in the morning, it will only reach working conditions by the middle of the day. An MHD installation is working in a few seconds. Therefore, power engineering workers can fully assume that this type station can take peak loads.

Now the matter is with the construction workers. These are busy days at Novomichurinsk. Not only is the sun beating down, but schedules are also pressing. G. Kkutylovskiy, MGDES construction boss and others look tired. They have enough worries. To an outsider they appear commonplace -- equipment is incompletely delivered, with long delays -- but the schedule is difficult to maintain without a precise work rhythm. The construction of the main building, which houses the 10,000 ton boiler, is under way at full speed. The boiler should be working next year. And the MHD unit itself two years later. However, just to install the magnet it is necessary to build a large assembly and repair shop, essentially an entire plant. It has arisen on what was recently an empty space.

The station is not only shops and equipment, but also a new school, which will open in September and housing -- temporary buildings are appearing one after another. Project managers intend to completely solve the hosing problem next year. By the five-year plan's end, in addition to a unique powe plant, there will be about 4,000 new apartments in Novomichurinsk.

The station building and the town are growing. So are people. At the project they increasingly talk about collective contract and weigh the advantages of the unregulated system. Without progressive organization work would soon stop. Although the Ryazan MGDES is still not among the working, one senses new rhythms at the site.

11574
CSO: 1861/14

BRIEFS

ELECTROSILA ASSOCIATION TURBINES-- Dozens of large electric power plants, both here and in foreign countries, are equipped with turbine and hydroelectric units made by the Elektrosila Production Association. The Leningrad machinery builders are giving a lot of help to CEMA countries in developing their power engineering. Products from the Association can be found in power plants in Bulgaria, Romania, Poland and Cuba. Scientific and technical collaboration contracts have been signed with machinery builders in the CKD-Praha Plant. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA] in Russian 12 Sep 86 p 2]

11574
CSO: 1861/14

UDC [681.51.629.12.03-83].001.63

SYSTEMS OF AUTOMATIC AND REMOTE CONTROL FOR SHIPBOARD ELECTRICAL POWER PLANTS

Leningrad SUDOSTROYENIYE in Russian No 11, Nov 86

[Article by R.A. Klebanov and A.N. Smirnov]

[Text] In the first stage of their development, control systems for shipboard electrical power plants (CSSSEP) were local and developed for each specific ship design. In this period, from 1960 to 1970, the "Argun", "Istra", "Irtysh", and "Izhma" systems were developed and installed on ships. With the introduction of comprehensive automation in hardware control on ships, a new stage of development was begun for shipboard electrical power plant control systems which - while fulfilling the local tasks of controlling and monitoring the starting up and operation of generator units - were connected with other ship hardware control systems according to a line of generalized signalling and control for the operation of the mechanisms and systems serving the generator units.

In this stage of development, the series of standardized and unified shipboard electrical power plant control systems of the "Izhora" type were worked out. The latter were introduced on ships at the beginning of the 1970s in the makeup of the "Zaliv"-type integrated hardware control (KSU "Zaliv"). These control systems for electrical power plants were made on the basis of unified design solutions adopted for all KSU-type [integrated control] systems.

The "Izhora" systems provide for the automatic and remote control from a central control station for shipboard electrical power plants as indicated in the table. They were developed on the basis of the following standardized automatic devices:

the USG-IP for synchronization of generators,
the URM for power distribution,
the UVR for switching on a standby,
the YTZ for generator overload protection,
the UKI for monitoring insulation resistance on the MDB [Main Distribution Board].

Comparison of Technical Characteristics of Different Shipboard Electrical Power Plant Control Systems

Functions carried out and technical characteristics	Izhora system	Izhora-M system	Swedish Stromberg Co. system
Switching on a standby DG [Diesel Generator] during: an overload,	+	+	+
loss of current at the panels of MDB [Main Distribution Board],	-	+	+
a malfunction of a DG or TG [Turbo-Generator]	-	+	+
Accurate automatic synchronization of generators	+	+	+
Automatic load distribution	+	+	+
Disconnection of nonvital power consumers during an overload	+	+	+
Blocking startup of high-power consumers	-	+	+
Monitoring insulation resistance of MDB buses	+	+	-
Alarm and Warning signalling	+	+	+
Remote control of electrical power plant	+	+	+
Transfer of primary power for Control System onto battery supply	-	+	+
Service life	10-12 yr	20 yr	*
Availability of electrical installation kit	-	+	-
Overall dimensions of control panel (or cabinet)	2516X 2055X 735	1900X 2050X 303	800X 2100X 800

* Data unavailable

Logical operations according to the composition of the scheme for control and monitoring are carried out by means of electromechanical relays arranged in relay modules. The principal elements of the system are situated in the control panel in the Central Control Station. The instruments for remote control and the monitoring and data elements are installed in the face panels of the switchboard.

The "Izhora" systems were assimilated in serial production and successfully carried out their functions on a large number of ships. Further development of the automation hardware and components, and the necessity for expansion of the functional capabilities were the reasons for development of a new generation of electrical power plant control systems.

In the beginning of the 1980s assimilation into production and use of the systems of electrical power plant control called "Izhora-M" (Figure 1) began and they are a component part of the "Zaliv-M" integrated control systems. For these systems, characteristically there is an expansion of functional and data capabilities, an increase of service life, a higher degree of intra- and intersystem standardization, and a a more modern component base (printed circuit boards, microcircuits, and microelectronic components).

Designwise the system is an integrated control panel consisting of cabinets, containers, and modules. The following functional units (modules) enter into the makeup of the automation of the new generation of electrical power plant control systems:

the BSG for synchronization of generators,
the BIAT for active current meters,
the BKZG for monitoring generator loading,
the BKPG for monitoring generator parameters,
the BRNG for load distribution,
the BKI for monitoring insulation resistance on the MDB.

A series of standardized modules, containers and cabinets were developed from which are assembled the add-on modifications to electrical power plant control systems for various ship classes. To increase the degree of standardization, in developing the basic diagrams and designs for a system, the parts which are constant and independent of ship class are separated from those that are variable. The latter depend on the number of generator units in the composition of the electrical power plant of a specific ship and the type of the driving engines. The constant part of the system includes the general monitoring functions and the protection of the electrical station. It occupies two racks of the control panel for the electrical power plant. Redundancy of equipment appears only with a small number of generator units in the electrical power plant (with two generators, redundancy is about 5 percent of the volume of the control panel).

The variable part of the system is a generator rack for two generators. The overall dimensions of a control panel for an electrical power plant made up of from two to six generator units amounts to from 1550 to 2250 mm along the front, 2000 mm in height, and 350 mm in depth (Figure 2). The high degree of

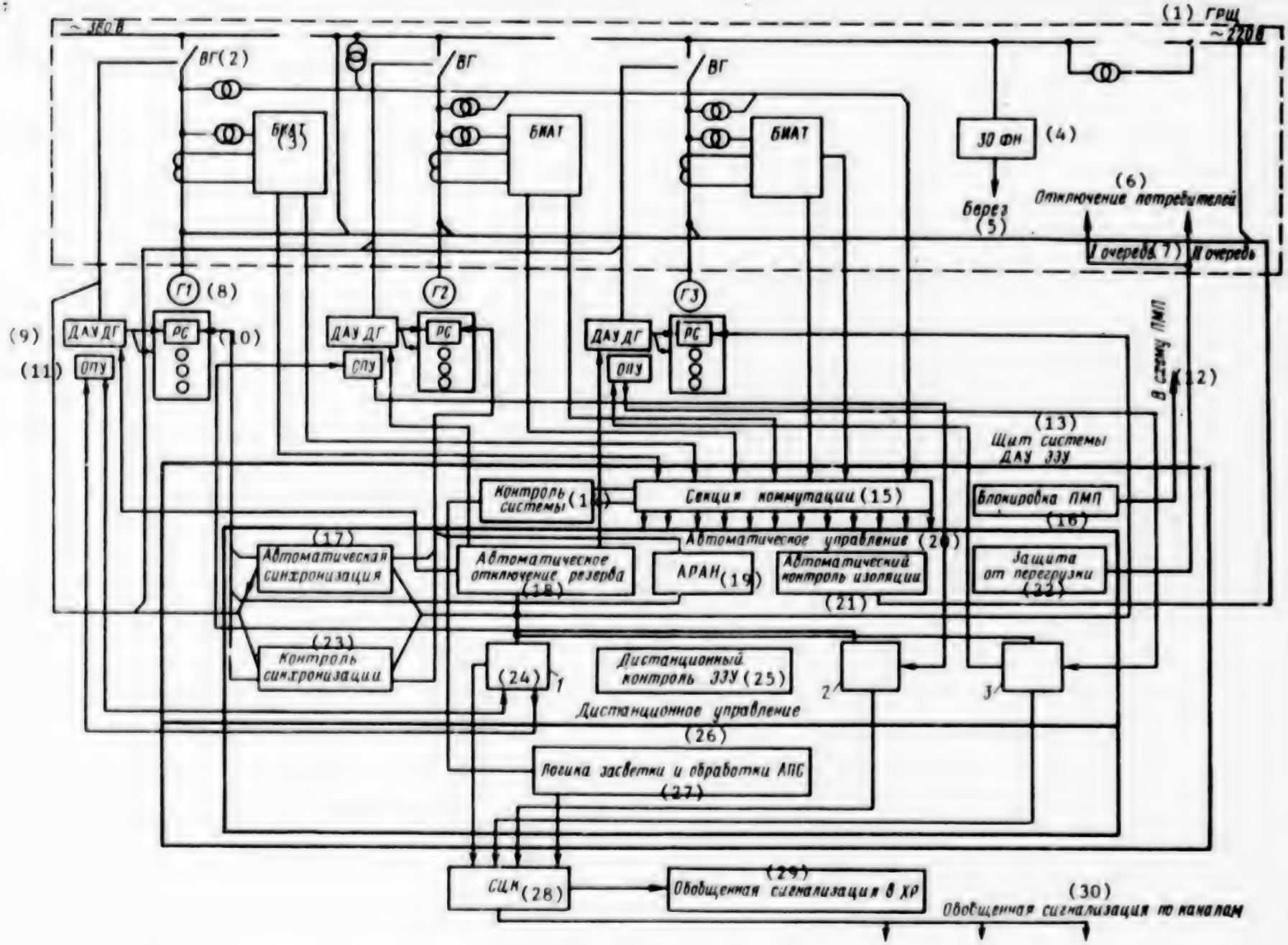

Figure 1. Functional diagram of "Izhora-M" system.

Key to Figure 1:

(1) MDB [Main Distribution Board]
(2) Generator switch
(3) Active current meter module
(4) Phase continuity device
(5) Bank
(6) Disconnection of consumers
(7) Priority I, priority II
(8) Generator 1, 2, 3
(9) Remote automatic control for diesel generator
(10) Speed regulator
(11) Primary diesel generator control station
(12) Into circuit for start-up of high-power consumers
(13) Panel for remote automatic control system of electric power plant
(14) Monitoring systems
(15) Commutation section
(16) Blocking of remote automatic control system
(17) Automatic synchronization
(18) Automatic standby disconnection
(19) Automatic distribution of active load
(20) Automatic control
(21) Automatic insulation monitoring
(22) Overload protection
(23) Monitoring synchronization
(24) 1, 2, 3 - Remote control and monitoring of Diesel Generators 1, 2, and 3 respectively
(25) Remote control of electrical power plant
(26) Remote control
(27) Logic for gating and processing alarm and warning signals
(28) Centralized monitoring system
(29) Generalized signalling in KhR [Pilot House]
(30) Generalized signalling along channels

standardization of "Izhora-M" systems has permitted the time for the design and manufacture of modifications of systems for different classes of ships and the costs of these systems to be substantially reduced.

In the development of the technical documentation, a series of basic documents such as the technical specifications, the description and instructions for operation, the program of tests and so on have been made common for all modifications of the system.

A comparison of the basic technical characteristics of the "Izhora-M" system with the "Izhora" system shows a number of advantages for the new system (see Table). Principal among them are:

- a higher degree of standardization which provides for a reduction of the cost of design work and a curtailment of the time for development, manufacture, and tests of systems;
- improved components;
- the construction of control panels is made easier;
- improved algorithms of control (startup of a standby diesel geanerator during de-energizing of the main distribution board, blocking of the startup of powerful consumers of electrical energy, startup of a standby diesel generator during the malfunction of a working diesel generator or turbogenerator, automatic transfer to battery power, and so on);
- the availability of an electrical installation kit which permits, as needed, carrying out installation work on the ship before the delivery of the instrumental part of the system.

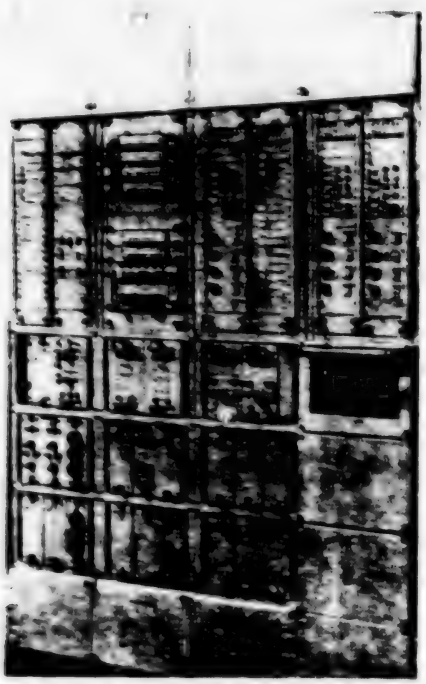

Figure 2. General view of control panel for an electrical power plant.

At present, 9 modifications of the "Izhora-M" system have been developed for ships of different classes having A2 and A1 degrees of automation according to the classifications of the USSR Register of Shipping.

According to experience in the manufacture and use of the system, a number of improvements have been introduced. Operation has confirmed the serviceability and the conformity of it with the imposed technical requirements. Comparison with similar foreign systems shows that in its basic technical characteristics the system conforms with modern demands.

It is necessary to note that electrical power plant control systems at present are heavily loaded with means for the presentation of information (indicator light panels). In the "Izhora-M" system the information section occupies about 50 percent of the volume of the control panel. Meanwhile, the number of signals brought out onto the face of the control panel, according to specifications for the development of new modifications of the "Izhora-M" system, continues to increase.

It seems advisable for designing and operating organizations to work on determining the optimum amount of information brought out on the control panel of an electrical power plant and to curtail it by the exclusion of secondary signals and the use of generalized signals for several parameters taking into account the interpretation of these parameters by mechanisms at local control stations as is provided for on similar foreign control panels.

Experience in the development of standardized eletrical power plant control systems has confirmed the advisability and necessity for standardizing shipboard electrical power plants themselves. In this, definite successes have been achieved; namely, standardized main current schemes, the conduct of work on the standardization of main distribution boards, the use of standardized electrical equipment, and so on.

Work on the standardization of technical means is being done with a high degree of coordination and care between the designing and operating organizations. Withdrawal from the demands for standardization of technical means leads to increased expenditures on the development and manufacture of control systems for these technical means. An example of the disagreement of a technical solution with the requirements for standardization is the disposition and numbering of the generator sections on the main distribution board and on the electrical power plant control panels from right to left on some ships instead of the generally accepted order of disposition and numbering of the sections of the main distribution board on ships from left to right. Such a practice violates the principle of standardization of equipment, and complicates installation work during the building period in the event of the use of a modification of the "Izhora-M" system developed earlier for another class of ship with an electrical power plant of similar consistency and generator power.

Interclass standardization of shipboard electrical power plant equipment permits development of a limited number of modifications of the "Izhora-M"

type of electrical power plant control system which will be suitable for a large number of classes of transport ships. In developing a new class of ship the designer can select and use one of the systems developed earlier for the standardized series.

The further development of shipbuilding puts new problems before shipboard electrical power plant control systems. One of these problems is the need for development of functionally new automatic devices serviceable during substantial distortions of the shapes of a curve of voltage or current supply where the coefficient of nonlinear distortion reaches 15-20 percent.

Such a problem occurs on ships having powerful direct current electrical drives supplied from the principal alternating current power system through thyristor rectifiers. Among these ships are oil-drilling ships, floating cranes and so forth.

The development of new hardware for computer engineering opens the possibility of using these means for the monitoring and control of electrical power plants.

The effect of the application in future generations of control systems of computer engineering equipment will intensify if these means are used for the solution of new problems peculiarly adapted to this hardware. Among these problems may be, for instance, the related problems of diagnosis and prognosis of the condition of electrical power plant equipment. For the solution of these problems, however, it is necessary for the developers of electrical power plant equipment to do the pertinent research for it in preparating to solve the problems of diagnosing technical condition (the determination of the algorithms for diagnosis and the prognosis of technical condition, the installation of appropriate sensors, and so on).

In conclusion it should be noted:

1. The development of the standardized series of "Izhora-M" electrical power plant control systems for maritime transport ships yields a substantial technical and economic gain including, in the first place, a reduction of the time and cost of designing and manufacturing these systems for different classes of ships, and the use of engineering solutions which have been tested in operation.

2. A high degree of intersystem standardization increases the modernization possibilities for the systems and reduces the time for their assimilation by servicing personnel on ships which has important value in connection with ships crews working in shifts.

3. The introduction on ships of standardized electrical power plant control systems simplifies the solution of problems connected with the organization of the repair and servicing of these systems in ports.

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CSO: 1861/124

RENEWED INTEREST IN AIRSHIPS FOR INDUSTRY USE DISCUSSED

Moscow STROITELNAYA GAZETA in Russian 23 Jan 87 p 3

[Article by M. Ariye, director of the Public Design Bureau for Aeronautics and candidate of technical sciences, Kiev, and subsequent commentary by RSFSR Gosstroy [State Committee for Construction Affairs] First Deputy Chairman N.V. Sukhanov and F.K. Salmanov, chief of Glavtyumengeologiya [Tyumen Geological Main Administration], Hero of the Soviet Union and Lenin Prize laureate, under the rubric "From Idea to Incorporation": "Be the Builder of a Dirigible?--The Kiev Engineers Consider It Realistic"]

> [Text] These flying machines have a unique combination of features: vertical takeoff and landing, large lift capacity, distance and duration of flight, safety of operation with the failure of the power plant and the control systems, low fuel consumption and minimal effect on the environment. You understand, of course: the discussion concerns dirigibles.

In England, for example, they have built about ten Skyship-500 and Skyship-600 dirigibles with a lift capacity of two and three tons. The creation of dirigibles with a lift capacity of 10 and 28 tons is projected for the near future. Flight testing is underway in the United States of a combined Helistan aerostatic aircraft with a lift capacity of about 24 tons.

Work is also being conducted in this area in our country. The Kiev Public Design Bureau of Aeronautics has been developing plans for aerostatic flying machines of various types since 1962. Our collective has united a large group of aviation engineers and scientists of a number of institutes of the USSR Academy of Sciences. Plans have been developed here for rigid-body D-1 and D-4 type dirigibles with a lift capacity of 14 and 120 tons respectively.

At the request of Glavtyumengeologiya, we have developed a plan for a combined aerostatic airship of a semi-rigid type with a lift capacity of up to thirty tons. It is a flying crane and is intended for the transport and installation of cargo in difficult-to-access and distant regions. Its flight speed reaches a hundred kilometers an hour. It can fly a thousand kilometers with a cargo of twenty tons. The flying altitude is up to two kilometers.

It is very important that the design of the airship utilize only series-produced domestic industrial materials, assemblies and equipment. This will allow the manufacture of an experimental prototype is a very short time. It will become the base and serve as the foundation for the creation of flying cranes with a lift capacity of a hundred tons or more.

The issue today is working documentation and the construction of experimental prototypes.

Naturally, this is not within the capabilities of a public design bureau, but only a state one equipped with specialists and possessing an experimental-production base.

Commentary of N.V. Sukhanov: A new approach to the resolution of transportation problems is essential in order to ensure the accelerated development of the productive forces of Siberia and the Far East and to raise the efficiency of capital investment in difficult-to-access regions. The existing plans for the shipment of cargo there by river, maritime and motor-vehicle transport are extremely complex. The capabilities of aviation, especially helicopters, are limited with regard to the large dimensions and great weights of modern cargo. Air shipment is moreover very expensive. Whereas for the national economy overall, the share of transportation expenditures in product costs is 10-12 percent, in the northern regions it reaches 50 to 60 percent.

Meanwhile, in these untamed regions, not only is the delivery of this freight required, but also its rapid unloading and storage and, if it is an industrial construction structural element, its installation as well. Aerostatic transport and installation apparatus can assist most efficiently in this, and plans for it have already been developed for over a decade by the Kiev Public Design Bureau for Aeronautics.

Specialists feel that the employment of aerostatic transportation equipment in the regions cited will make it possible to obtain an economic impact of no less than three million rubles a year. Furthermore, it cannot fail to be taken into account that this equipment is more acceptable for the natural conditions of the North. It should therefore be acknowledged that the work of the Kiev Public KB [Design Bureau] is of enormous national-economic importance and requires every kind of support.

Commentary of F.K. Salmanov: The geologic-survey workers of Tyumen, especially at the current stage of oil- and gas-field prospecting, run up against a multitude of difficulties. Chief among them is the lack of roads. The lift capacity of modern helicopters is not satisfactory for us. They cannot transfer drilling rig units, equipment and living quarters great distances.

The aircraft-construction department of the Moscow Aviation Institute, headed by USSR Academy of Sciences Corresponding Member and Hero of Socialist Labor S.M. Yeger, has already created a plan for a dirigible with a large lift capacity. The developments of the Kiev enthusiasts are also promising... The time has come to impart a planned nature to this work. In our opinion,

dirigibles have a great future. They will generate an enormous economic impact. After all, millions of rubles are expended in our main administration alone for the construction and maintenance of thousands of kilometers of temporary roads, dozens of substations and helicopter areas. And so many people are employed in the servicing and operation of the tractor-trailer fleet! If we obtain dirigibles, much of this will become unnecessary.

Much funding is expended on the scientific research operations of Glavtyumengeologiya. More than six million rubles a year are spent for this purpose. And of course we, who have such a vested interest in the development and incorporation of dirigibles, are prepared to give assistance and support to the organizations resolving this problem.

From the editors: The dirigible last flew in our country almost forty years ago. Unsuccessful experiments of the past and the appearance of helicopters and more powerful aircraft placed the need for the slow and awkward-looking flying machines in doubt. The discussion between supporters and opponents of this type of transport has been underway in the press for less than a year. Even specialists, even the most authoritative ones, are still expressing extreme points of view: from the categorical denial of dirigibles to calls for the arrangement of their series production in the near future. Only practice can put an end to the dispute. The efforts of many enthusiasts have already generated plans for new-generation dirigibles that meet modern requirements according to all parameters. Thus, the developments of the Kiev Public KB have been highly regarded at the GKNT [State Committee for Science and Technology], Goskomizobreteniy [State Committee for Inventions and Discoveries], the Central Committee of the VOIR [All-Union Society of Inventors and Innovators] and among the specialists of other departments. The creators of the dirigible have been issued a certificate for a commercial prototype.

The need for such flying machines is great today. Certain organizations are also prepared to render financial support for the planning and manufacture of an experimental prototype. The necessity of a planning procedure for the development of this type of air transport has become acute. The topic cannot be withdrawn "volitionally," taking into account the development and promise of the modular-unit method of construction. The situation is still taking shape in this manner: those who would like to receive the new equipment are completely "in favor," while the potential manufacturers--the aviation industry and civil aviation--are categorically against. Apparently this very important intersectorial problem will have to be resolved with the aid of USSR Gosplan.

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NEW MATERIALS FOR MACHINE BUILDING

Moscow MASHINOSTROITEL in Russian No 10, Oct 86 pp 3-5

[Article under the rubric "For Speeding Scientific and Technical Progress", by Yu.A. Starostinetskiy, leader, technology group, Minsk Special Design Bureau for Broaching Machines: "The Green Light for New Materials"]

[Text] The use of new promising materials represents a definite contribution to the accomplishment of the objectives of developing and introducing equipment which practically eliminates or reduces to a minimum the participation of man in its operation.

For example, the concept of reliability is associated with still frequent failures in the operation of a machine tool which are generated in friction pairs. Special metallic materials and alloys subjected (when necessary) to thermal, chemical-and-thermal and other kinds of treatment are widely used for purposes of enhancing the serviceability and antifriction properties of friction pairs. A considerable shortcoming of these materials is the impossibility of using them without supplying a lubricant to the friction zone, and under certain operating conditions a lubricant is required which possesses antiskip and antiscoring properties.

Antifriction materials such as filled fluoroplastics and polymer coating compounds based on diane epoxy resins are used at the present time (though to a quite limited extent). The fillers of resins (bronze powder, graphite, molybdenum disulfide, copper nitrate and other components) provide wear resistance and wear-in ability for the polymer coating, as well as self-lubrication, heat stability and a minimal friction coefficient. They form on the friction surface a passivating film which reduces the wear of the metal surface interfacting the coating. The incorporation of polymer coatings not only improves the operating characteristics of a friction pair, but also considerably reduces the labor intensiveness of its manufacture.

Their antiscoring properties, as well as the ability to work without a lubricant (though for just a limited time, since the wear of a fluoroplastic and polymer coating becomes quite intense) are advantages of fluoroplastic and polymer coatings.

Further improved self-lubricating materials are needed to replace traditional materials. A dark brown closely woven fabric which is in no way noteworthy in appearance, covering a friction surface, is able to improve by a high factor the service life of a design and its reliability, and to reduce vibrations and the noise level--and all this under conditions of dry friction without the supplying of a lubricant. The metal content of the design is reduced considerably and the cost of routine maintenance is lowered sharply. This fabric is self-lubricating "organovoloknit" [organic synthetic fiber material]. It contains two types of fibers--antifriction (polytetrafluoroethylene) and reinforcing (polyimide, polyethylene terephthalate, polyvinyl alcohol, cotton, etc.). The fabric is attached to any material by cementing. The covering's thickness is from 0.2 to 1 mm. The wide temperature range for the effective operation of a covering of this fabric (from -150 deg C to +250 deg C) and its high supporting capacity (unit loads of several tons per square centimeter are permissible) considerably span the operating conditions of machine tools.

The high serviceability of this self-lubricating fabric has been confirmed in tests in the headstock sliding bases of model 8G681 and MP6-950 circular saw slitting machines. It functions normally where a metal-filled fluoroplastic proved to be unserviceable.

More or less considerable industrial engineering difficulties (working out the optimal design and production process, questions of supply etc.) are involved in the introduction of every new thing, but here problems on the psychological plane occasionally prove to be dominating. The borrowing of advanced domestic know-how and the achievements of foreign firms is a totally natural and necessary process. However, the viewpoint of some technical supervisors boils down just to borrowing, totally excluding the elements of initiative, creativity and ingenuity. Frequently, in proposing the implementation of a specific idea, the "indefagitable" initiator hears in reply not basic objections but the trite question: "Who will use it?" And often the negative reply gives rise to an insuperable psychological barrier. A creative beginning is necessary above all in any pursuit. To begin is always difficult, of course, but to follow in one's footsteps is to constantly catch up. This is explainable and justified from a tactical viewpoint in a number of cases, but impermissible from the strategic viewpoint.

A polyamide-base self-lubricating antifriction material ("maslyanit") is eight times lighter and five times less expensive than bronze. Sliding bases made of "maslyanit" absorb (depending on operating conditions) loads of up to 35 MPa at speeds of 0.1 to 0.3 m/s. Operating parameters can be increased considerably (to several meters per second) by using a cooled base. The operating temperature range is from -20 to +180 deg C (individual types of "maslyanit" have an even greater range). It is obvious that this material deserves speedier introduction at the country's machine building enterprises. However, you can be sure that many are not knowledgeable about the material, and those knowledgeable are encountering problems on the supply level. Certainly not everything desirable is easily realized. Definite involvement and enterprise must be displayed for this.

Self-lubricating materials of the SAM group [not further identified] are of interest. They are converted to products by the method of injection molding on standard equipment (automatic machines for thermoplastic materials, molding presses). In exceeding by a total of just 10 to 30 percent the cost of the basic thermoplastic materials (polyamides, polyacetals and polyolefins), SAM's filled with reinforcing additions, lubricants and other components surpass them by a factor of 5 to 10 in terms of operating parameters. By varying the additions, it is possible to adjust their physicomechanical characteristics over a wide range of values.

In speaking of ways of improving the wear resistance of friction pairs, one should not overlook the still little known process of "epilamating" surfaces. An "epilama" is a film of surface-active agents (PAV's). In covering the working surface of a part (in a film millionths of a millimeter thick), it imparts high wear resistance to it, lowers the friction coefficient, prevents the formation and growth of microcracks on the working surface under dynamic loading, and promotes better retention of the lubricant.

Drills, keyway milling and hobbing cutters, gear cutters--this is far from a complete list of tools which have proven the effectiveness of this process (their dimensional stability increased by a factor of two to four). And rubber rings subjected to epilamating in a boiling compound have had a more than fivefold improvement in wear resistance. Epilamating considerably stabilizes the movement of carriages, rams and tables along the guideways of metal-cutting machine tools, improving severalfold the accuracy of their arrival at the assigned position, which is an exceptionally important parameter of NC machine tools.

The question arises: What is interfering with the extensive introduction of this process in production? The answer is the same--a psychological barrier, associated this time with lack of clarification of the process's physical effects. However, the area of application of epilamating is expanding constantly, and professional interest speaks for the necessity of its speedy and total introduction in machine tool building.

One fairly frequent failure in the operation of equipment is the seal failure of fixed joints. Sealing is achieved as a rule by using all kinds of rubber, cardboard and other gaskets which do not guarantee reliable sealing, but the fabrication and installation of which involve the definite input of labor. Furthermore, there are special requirements for the machining quality of the joined surfaces; special shoulders, scrolls and grooves are made, and sometimes even labor-intensive lapping work is performed. This can be avoided if a so-called "liquid" gasket is used, of the KLT-75T type, for example. Applied in a thin layer in the form of a pastelike mass onto one of the surfaces to be joined, this gasket, 30 to 35 minutes after assembly of the joint (the time for polymerization to a rubberlike state), is able to withstand pressure of up to 60 MPa. A gap of up to 0.3 mm can be sealed. The operating temperature range is from -60 deg C to +300 deg C. The effectiveness of the use of KLT-75T is displayed not only in reliable sealing of the joint, but also in the ability to reduce by a factor of 1.3 to 1.5 the number of fasteners used. But many problems must be solved for the widescale introduction of a "liquid" gasket, including increasing the quantity in which

it is produced, automation of its application, and overcoming the psychological barrier.

A metal-cutting machine tool--that tireless toiler--is constantly subjected to the influence of cutting forces and vibration. Lock washers and cotter pins, lock nuts and lock pins far from always perform their service flawlessly. If one or two drops of a greenish viscous liquid are applied to the threaded surface of a screw and the nut is screwed onto it and it is left to set for a few dozen minutes, then the threaded connection is not inferior in reliability to, but occasionally is even superior to a lock-type connection. Remaining detachable, the joint is capable of withstanding considerable dynamic loads. But what is this liquid? It's a cement sealing compound of the Unigerm and Anaterm series, anaerobic, i.e., polymerizing when its contact with the air's oxygen is cut off. The cement is highly penetrating and will fill in the gaps between parts to be joined and surface micro- and macro-irregularities. This makes possible the sealing of joints and such a reliable mechanical bond between parts that in many cases it is possible to do away with press-fitted joints by replacing them with slip joints. And this in turn eliminates press fitting and prevents the internal stresses and microcracks which originate in the process, and deformation of the joined parts with impairment of their dimensional and geometrical precision.

The operating temperature range of anaerobic cement sealing compounds is from -60 to +150 °C. The maximum gap which can be filled depends on the type and purpose of the cement and is as great as 0.45 mm. Joints produced by means of this type of cement can be used in oil, fuel, gases and emulsions and thereby withstand a working pressure of up to 30 MPa. The cements can be supplied in small airtight polyethylene bottles, as well as in microcapsules (in a gelatin envelope). The powdery microcapsules applied to a threaded surface in the assembly of a joint, upon breaking, release the cement, which fills the gap.

Cement sealing compounds are being used in hydraulic and pneumatic system joints in machine tools and transfer lines, in sealing fixed joints in gearheads, spindle and other assemblies, as well as as a component of powdered cement compounds in the elimination of macroflaws in casting and machining. As compared with a material based on epoxy resins, powdered cement compounds (aluminum, iron, copper and other powders are used as fillers) speed up by a two-digit factor the elimination of flaws, because of practically shrinkless and very rapid (5 to 15 min, depending on the material of the powder) polymerization. They have been a worthy competitor of the soldering and welding of flaws, by ensuring not only great airtightness, but also mechanical strength for constructions.

Individual types of cements are also being used for impregnating welded joints and porous castings to ensure their airtightness. Work is under way on improving and developing new types of high-strength cements, including cements which absorb considerable working loads, which make it possible to do away with traditional methods of joining parts mechanically. It cannot be said that cement materials are not being introduced in machine tool building, but insufficiently actively. The reason is the same psychological barrier (or the insufficient competence of services which supply individual plants).

Today's machine tools and transfer lines and robotic systems are to a considerable degree hydraulicized, i.e., are saturated with pipeline systems. We know how much effort it takes to prepare pipes before installing and using them. Of interest on this level are flexible polymer hoses, which are used in the practice of machine tool building all over the world. Two types are produced--low-pressure and high-pressure (polyvinyl chloride and polyamide). The introduction of polymer hoses has resulted not only in cleaner oil in hydraulic systems, but also the more attractive appearance of machine tool equipment and a reduction of its metal content. One of the reasons for slowing the introduction of polymer hoses is the lack of a centralized production facility for connecting components; therefore, individual enthusiastic plants are making them independently.

The quality of today's equipment, including metalworking equipment, is determined not only by functional parameters, but also by its esthetic level. Often machine tools are replete with all kinds of manufacturers' and other nameplates made of sheet metal, Dural and other metallic materials, attached with rivets or screws of a far from esthetic kind. Adhesive labels should be used to replace them. Colorfully produced by printing on a polyethylene terephthalate film, they not only improve the external appearance of machine tools, but also considerably reduce their metal content. Their introduction depends mainly on organization of their centralized fabrication in accordance with orders from organizations.

Just a partial analysis of the potential latent in the introduction of new materials reveals a colossal source of supply for fundamental, essentially new reforms in machine tool building. A saving amounting to hundreds of millions of rubles is anticipated here. But a much greater saving will be gained in the country's national economy as the result of improvement of the quality of machine tool equipment.

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PROBABILISTIC ESTIMATION OF RIGIDITY AND ACCURACY OF FORMING HEADS IN METAL-CUTTING MACHINE TOOLS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 5, May 86 (manuscript received 3 Dec 85) pp 153-157

[Article by N.P. Dyakonova, candidate of technical sciences]

[Abstract] A new method of calculating displacements in elastic components of machine tools under variable external forces has been developed at the Department of Machine Tools and Automatic Machines, Moscow Higher Technical School imeni N.E. Bauman, for rigidity and accuracy analysis. A machining system is, according to this method, represented as a combination of purely elastic and purely inelastic resistance elements, the inelastic ones including dry and viscous friction pairs. The effect of a variable load is calculated on a probabilistic basis by the Monte Carlo method. For illustration, the method is applied to the spindle assembly on a ball bearing and a roller bearing in a YeT-50 lathe. The assembly is represented by an equivalent combination of elastic and inelastic elements with series and parallel coupling. Displacements in the mandrel-spindle interface fit under a variable radial force acting on the extension beyond the roller bearing, calculated by this method, yield the tolerance range essential to design of such an assembly for rigidity and accuracy. Figures 3; references 5: all Russian.

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OPTIMUM PARAMETERS OF POLYHARMONIC NORMAL VIBRATIONS DURING TWO-COMPONENT VIBRATORY TRANSPORTATION

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 5, May 86 (manuscript received 22 Jan 85) pp 157-160

[Article by I.I. Vrublevskiy, engineer]

[Abstract] Two-component vibratory transportation of materials and parts is considered, separate excitation of longitudinal and normal vibrations being preferable to excitation of unidirectional vibrations on account of higher attainable forward velocity and less likely "hopping" of the materials or parts. The motion of a particle on an inclined rough plane surface performing simultaneously harmonic longitudinal and polyharmonic normal vibrations with an optimum phase shift between harmonics is modeled. The differential equation describing this motion is formulated in a system of coordinates rigidly fixed to the vibrating plane, assuming a two-stage high-velocity "non-hopping" mode with dry friction ideally the only resistance force. An analysis of this equation, with the aid of a digital computer for numerical data, indicates the optimum vibration angular acceleration and phase shift between harmonics as well as inclination angle of the plane for maximum transport velocity. Figures 3; references 4: all Russian.

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MULTIPATH GEAR-FRICTION PLANETARY TRANSMISSIONS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 86 pp 18-21

[Article by L.M. Ivachev, engineer]

[Abstract] The most common gear transmission used in the world is the three-path planetary transmission in which manufacturing errors are compensated by the use of a floating central gear. A new trend has been developed, multipath gear-friction planetary transmissions, in which each of the parallel power paths includes friction elements for uniform distribution of torque among all of the power paths and compensation of various errors in manufacture, assembly, operating wear, etc. The number of power paths is significantly increased in these transmissions by placement of satellites both around the circumference of the central axis and along the central axis. The distinguishing design features of these transmissions are:
1) Satellites made of individual coaxial driving and driven gears interconnected by friction clutches spring loaded in the axial direction;
2) driving and driven gears of the satellites are installed axially in

pairs and are made as satellite blocks located around the central axis of the transmission; 3) the satellite gears are located in both the circumferential and axial directions, increasing their number several times, as well as the number of contact spots while simultaneously decreasing the length of the contact lines on the gear teeth. An example diagram of such a transmission is presented. Figure 1; references 8: Russian.

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HIGH PRESSURE FAN UNITS

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 86 pp 32-34

[Article by Candidate of Technical Sciences A.V. Ryabov, Engineer Yu.M. Umanskiy and Engineer T.A. Yarovenko]

[Abstract] An attempt is made to simplify the method of selection and to standardize the types and sizes of high pressure fans available. The work was based on the experience of selecting medium pressure fans in combination with electric motors, belt drives and vibration damping systems. Graphs were constructed for selection of fan units according to technical data presented in tabular form. Two examples of selection of the proper fan unit using the curves on the graph are presented. Figures 2; references 4: Russian.

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INFLUENCE OF TEMPERATURES AND THEIR DISTRIBUTION OVER THE SEAM WIDTH ON STRENGTH OF BUTT JOINTS PRODUCED BY ULTRASONIC WELDING OF RIGID PLASTICS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 11, Nov 86 (manuscript received 23 Apr 86) pp 118-121

[Article by Engineer A.A. Chesnokov and Candidates of Technical Sciences S.S. Volkov and A.N. Smirnov]

[Abstract] A study is made to determine the reasons for a decrease in the strength of butt joints in rigid plastics 10-15 mm thick produced by ultrasonic welding and to develop recommendations for selecting an effective edge finishing design. Specimens of impact resistant polystyrene 50x15x10 mm in size were welded on an MTU-1.5 installation using a model UZG-2-4 ultrasonic

oscillator operating at 21.7 kHz. The distribution of strength over the width of the seams was measured by cutting the welded specimens into five strips in the longitudinal direction and testing each of them under tension. It was found that the maximum strength was achieved at the center of the welded joint near the location of a V-shaped projection in one of the two pieces welded together. Strength decreased greatly with increasing distance from the V-shaped projection. This ultrasonic oscillation concentrator thus produced good quality ultrasonic welded joints. The use of multiple projections increased joint strength over the entire length of the joint. It was experimentally established that the optimal ratio of heights of neighboring projections is 1.3-1.5 with a height of the central projection of 2 mm. This makes the distribution of temperature through the width of the seam more uniform and improves seam strength. Figures 3; references 4: 3 Russian, 1 Western.

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EFFECT OF ELECTRODE GAP GEOMETRY ON CURRENT DISTRIBUTION DURING ROUNDING-OFF OF EDGES BY ELECTROCHEMICAL MACHINING

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 25 Mar 85) pp 20-24

[Article by Yu.M. Vakhitov and A.Kh. Karimov]

[Abstract] Rounding-off sharp edges in gas-turbine engines increases their reliability and life. Often, rounded-off edges must have variable radii. Usually rounding-off is done manually. This operation can be mechanized, using electrochemical dimensional machining (EKhO). In order to make a variable radius, non-uniform metal removal must be performed. It can be done by creating non-uniform current density i. Under constant EKhO conditions along the machined edge i can only be controlled by varying geometric characteristics of electrode clearance: the shape and dimensions of the tool electrode surface and the initial electrode clearance, as well as by means of insulating shields. A typical schematic of rounding-off sharp edges by means of the EKhO method was shown. Little studied dependences of i on process parameters were examined. Calculation of i distribution on the machined edge surface was reduced to solving an electrostatic field problem. Assuming that the electrical field in the gap was stationary and potential and that conductivity of interelectrode medium (electrolyte) and electrode potentials were constant, distribution of potential U in the gap was described by a Laplace equation. The equation can be solved analytically only for the case of the simplest shape of electrode edges, and in most cases it is impossible to take into account the effect of tool electrode shape and dimensions. Analog simulation of electrode clearance on electrically conductive paper made it possible to solve the problem for any gap geometry. In this

case, the analytical solution of the Laplace equation was replaced by direct measurement of potentials or gradients thereof (grad U) on the model. 250:1 scale models of chosen gap geometry were made of electrically conductive paper, then, using electrointegrator EGDA 9/60, equipotentials and current lines of force were plotted. The derived grid of orthogonal curves presented qualitative and quantitative characteristics of the electrical field in the gap. Results of measurements, plottings and calculations were presented and analyzed. Based on the analysis, practical recommendations for design of tool electrodes were made. Figures 5; references: 3 Russian.

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DYNAMICS OF CAVITY DEVELOPMENT IN MARBLE TARGET UNDER 1.06 MICROMETERS WAVELENGTH RADIATION

Frunze IZVESTIYA AKADEMII NAUK KIRGIZSKOY SSR in Russian No 4, Jul-Aug 86 (manuscript received 10 Apr 86) pp 20-22

[Article by Zh.Zh. Zheyenbayev, E.S. Chokoyev and O.T. Abdyldayev (Physics Institute, Kirgiz SSR Academy of Sciences]

[Abstract] Experimental studies of the dynamics of cavity development on a marble surface, when the cavity developed during marble evaporation, caused by steady-state laser radiation, were conducted. A solid state YAG laser with CW mode output power of 120 W at 1.06 μm wavelength was employed in the experiments. Laser radiation was focused by a quartz lens with focal length of 5 cm; the focal spot diameter was equal to 0.3 mm. White coarse-grained marble was chosen as a target. Cavity parameters were measured with a specially developed optical micrometer with accuracy not worse than 50 microns. Experimental material was obtained by statistical accumulation and comparison of data at various exposures and intensities of laser radiation. The obtained empiric data demonstrated dependence of cavity depth on intensity of incident laser radiation. At long enough exposures, growth of cavity depth ended for all intensity values. An explanation of the most probable cuase of this phenomenon was offered. Growth of cavity diameter on the surface of a specimen was slowing down as exposure increased. Cavity shape was close to a paraboloid. The character of time change of efficiency of the process of marble evaporation, caused by laser radiation, was examined. Cavity volume due to evaporation of target material was only increasing up to exposures of 10-15 s. Further increase of exposure did not produce any tangible effect. Hence a conclusion was made that, as exposure increases, efficiency of marble destruction by evaporation sharply decreases. The experimental material demonstrated that for efficient destruction of marble by melting and evaporation one should employ lasers with highest possible power, while continuously scanning the laser beam along the cutting line. Figures 2; references 6: 5 Russian, 1 Western.

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EMERGENCY REPAIR OF TVV-500-2 TURBOGENERATOR ROTOR

Moscow ENERGETIK in Russian No 6, Jun 86 pp 21-22

[Article by V. M. Baychikov, I. G. Vibe, V. A. Yakorkhin, Sredazremenergo-Ekibastuzenergoremont]

[Text] In 1985 serious damage occurred to the rotor winding of a TVV-500-2 turbogenerator because a ferromagnetic foreign object from the drive fell inside the turbine shroud, shorting out the No. 7 and 8 upper coil windings of terminal No. 2. The resulting arc burned out the shroud insulation, as a result of which the upper winding of coil No. 8 shorted to the ground via the copper damper winding segment, causing another arc between the shroud ring, which carried the potential of the No. 8 upper coil winding, and the No. 6 upper coil winding, on the No. 7 coil side.

The following damage resulted from the two successive arcs:

A spot of oxidation tint 140 x 170 mm on the inner surface of the turbine shroud;

Melting of copper through the entire depth of the No. 8 upper semi-winding from coil No. 7 on a 130 x 25 mm area;

Melting of copper of the upper semi-winding of the No. 7 coil in two segments (50 x 15 mm through the entire depth on the No. 8 side and 30 x 5 mm to 3 mm depth on the No. 6 side);

Warping of the upper windings of coils Nos. 6, 7, and 8 to 5 mm in the zone of the arc's thermal effect;

Melting and charring of fiberglass laminate parts in the area of damage.

Using known technology the repair of turbogenerators in similar situations would require no less than 2 months with corresponding preparation. Upon the suggestion of electrical repair workers at the Sredazremenergo production association and with the consent of the producing factory, a "quick-fix"

rebuilding solution was implemented to the damaged rotor without loss of quality or reliability.

A donor rotor located at the power station which was not part of the reconstruction was used for this repair version. This "quick-fix" repair technology contains the following operations:

Disassembly of essential rotor assemblies and components and conducting diagnostics on them to determine their viability while the damaged ones are repaired;

Removal of the damaged sections of the upper windings of coils Nos. 6, 7, and 8 and their winding insulation up to 150-200 mm into the grooves, and also the wedges and remains of the damaged insulation;

Installation of the winding insulation and soldering of copper inserts with insignificant misalignment;

Installation of insulating wedges and wedging of the grooves;

Installation of the shroud insulation, copper damping segments and mounting of the turbine shroud.

Tests were made after the repair, which the rotor passed. One work week was needed for the realization of this "quick-fix" of emergency rotor repair.

13320
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EXPERIENCE IN OVERHAULING TGB-500-4 TURBOGENERATORS

Moscow ENERGETIK in Russian No 12, Dec 86 pp 10-11

[Article by R.M. Gavrilishin and M.I. Shcheglov, engineers, Lvovenergoremont]

[Text] Mastering the process of overhauling 500 MW, 1500-rpm TGV-500-4 turbogenerators, distinguished by their unique design, which are installed in power generating unit No 5 at the Novovorezh nuclear power station, was an important task put before the Lvovenergoremont enterprise in the 11th Five-Year Plan.

For this purpose, specialists from the Elektrotyazhmash plant were sent to study the technological design documentation of the TGV-500-4 turbogenerators and to become familiar with the unique features of their production, assembly, and installation.

Then the enterprise's workers developed standardized technical and manufacturing documentation for major overhaul of the TGV-500-4 turbogenerator, including the technical specifications and industrial process for the overhaul. These documents establish the technical requirements for components, assembly units, the turbogenerator as a whole during disassembly and repair, and certification after the repair. Moreover, a portfolio of various schemes for slinging the dismountable assembly units (components) of the turbogenerator was developed.

The following types of work were included in the industrial process: disassmebly and assembly of the turbogenerator as a whole and its component parts; cleaning and repair of the turbogenerator's component parts during the dismantling, assembly, and repair process; and checking and testing of the turbogenerator and its component parts during the dismantling, assembly, and repair process.

The introduction of standard technical and manufacturing documentation allowed the establishment of unified technical requirements for the overhaul, and certification methods during the overhaul process; the assurance of effective use of the advanced patterns and methods of overhaul; and the improvement of labor productivity by 7%. The development of standardized technical documentation for the overhaul of the TGV-500-4 turbogenerator earned the bronze medal of the Exhibition of Achievements of the National Economy of the USSR.

Among the things successfully introduced while the TGV-500-4 turbogenerator overhaul was conducted were: organizational and technical, industrial, and rigging equipment, including complex and unique objects like an electric power assembly, an inflexible inductor for induction heating of the rotor shroud, a lubrication system with hydraulic cylinders for mounting and dismounting the rotor shroud, etc.

Great preparatory work for conducting the overhaul by brigades was completed by the Lvovenergoremont enterprise. In the process, time standards for the overhaul of the TGV-500-4 turbogenerator and the BTV-500-4 exciter were developed.

Organizing socialist emulation on the part of the workers and the technical engineering personnel taking part in the overhaul and their emotional and material stimulation were important during the process.

During the overhaul of the TGV-500-4 turbogenerators the Lvovenergoremont enterprise and the producing factory jointly redesigned them, increasing their reliability and the time between servicing.

Among the redesign measures should be noted:

The prevention of thermal imbalance of the rotor by equalization of the hydraulic resistances of the windings cooling system with increase in the working pressure of the distillate from 1 to 2.5 MPa;

Redesign of the water discharge apparatus from the rotor, the rotor's water channel, the shroud oil seals, and rectifier units of the BTV-500-4;

Installation of the gas separating cylinders on the end parts of the stator winding in order to improve the cooling of the stator.

The high level of technological preparedness for the overhaul on the part of the enterprise, the introduction of leading overhaul methods, and the improved industrial rigging in the complex, along with the progressive form of organization of and payment for labor and high level of organization of socialist emulation permit the overhaul of TGV-500-4 turbogenerators on a high technical and organizational level, in shortened periods of time and with high quality.

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CSO: 1861/107

UDC 621.165.001.5

STUDY OF STEAM TURBINE ROTOR MATERIAL IN HOT CHANNEL ZONE AFTER LONG TERM OPERATION

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 12, Dec 86 pp 37-38

[Article by Engineer L.I. Stolyarova, Engineer V.I. Seryakov, Doctor of Technical Sciences V.P. Rabinovich, Candidate of Technical Sciences M.G. Kabelevskiy and Candidate of Technical Sciences L.A. Metashop]

[Abstract] The results are analyzed of a study of the rotor of a type K-160-130 steam turbine after 140,000 hours including 121 starts. The studies showed no significant change in brittle fracture resistance, thermal and short-cycle fatigue strength. However, in the hot channel area the short-cycle fatigue strength was reduced by a factor as great as 1.8. Studies should be continued on order to develop the optimal method for estimating the remaining service life of steam turbines. Figures 3; references 3: Russian.

6508/9835
CSO: 1861/88

UDC 621.2:621.514

CALCULATION OF GEOMETRIC PARAMETERS OF SCREW COMPRESSORS

Moscow KHIMICHESKOYE I NEFTYANOYE MASHINOSTROYENIYE in Russian No 10, Oct 86 pp 11-12

[Article by Candidate of Technical Sciences A.N. Vinogranov, Engineer S.A. Volodichev, Candidates of Technical Sciences G.A. Kanyshev and V.Ye. Konstantinov and Engineer N.P. Kuryshkin]

[Abstract] Results are presented from a study of the influence of the basic geometric parameters of meshing of rotors on output quality characteristics of screw compressors performed at the Moscow Higher Technical School imeni N.E. Bauman and VNIIkholodmash [All-Union Scientific Research Institute of Refrigeration Machinery]. The experiments were performed on a

typical screw compressor with asymmetrical rotor tooth profile, with total depression area, total length of tooth contact line, triangular slot area, tooth tip radius on the driving rotor and various combinations of tooth profiles as the variable parameters. It was found that increasing driving rotor tooth tip radius by 6% increased compressor throughput by 20% while also increasing contact line length by 6.5%, requiring a change in the parameters of the tooth profiles, which decreased theoretical output. Geometric parameters were subdivided into three types: The radii of curvature and number of teeth of the screws, profile of rotor teeth, and movement of the end profile in space. Equations are derived which allow, given fixed numbers of teeth, determination of the maximum and minimum ratios of radii of curvature of the rotor tips. The results of the studies allow optimization of the geometry of the flow-carrying sections of screw compressors given the required output and power characteristics. Figure 1; references 2: Russian.

6508/9835
CSO: 1861/84

UDC 621.73.04:621.7.08

REFINEMENT OF CRITERIA FOR EVALUATING PRECISION OF BLADE FORGINGS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 7, Jul 86 pp 21-24

[Article by Ye.P. Bulat, candidate of technical sciences]

[Abstract] The concept of precision forging is defined in terms of finish tolerances and applied to turbine or compressor blades, while forgings are classified into three groups according to the allowance for intermediate forming operations which will yield precision forgings. In the first group belong blade forgings of corrosion-resistant steel which require two rough machining operations (with chips). In the second group belong blade forgings which require one rough machining operation and electrochemical treatment. In the third group belong blade forgings which require fine machining (without chips). The corresponding ranges of allowance are $A>5.0$ mm, $1.0 \leq A \leq 5.0$ mm, $A<1.0$ mm respectively. Two additional designer groups of forgings are those with $A = \text{const}$ (0.15-0.5 mm) and $A = 0$ respectively. The allowance range is coordinated with surface roughness and cracking depth, for design and quality control purposes. Design tolerances are established so as to limit deviations from critical blade dimensions and to ensure finished blades conforming to applicable All-Union Standards or All-Union State Standards. Figures 2; tables 1; references 4: Russian.

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OUTLOOK FOR DEVELOPMENT AND IMPROVEMENT OF STEAM TURBINES PRODUCED BY THE 'NEVSKIY ZAVOD' PRODUCTION ASSOCIATION

Moscow ENERGOMASHINOSTROYENIYE in Russian No 7, Jul 86 pp 42-43

[Article by Engineers A.S. Andreyev, V.M. Stepanov, and V.P. Filaretov]

[Abstract] Scientific research and engineering effort have resulted in updating of production facilities at the 'Nevskiy Zavod' manufacturing plant and in a redesign of the steam turbines it produces. These include the AKV-12-IV, AKV-12-V, AKV-18-II, AKV-18-III, VKV-22-I line and the K-12-35-2, K-12-35-3, K-15-41-1, K-19-35-2 line for central heating plants as well as the K-1290-121 and the P-18-3.4/0.8, P-23-8.8/0.8, P-30-100/41-1, R-10-130/29 line for compressor drives. These turbines are more reliable, have better performance characteristics matching their respective applications, and contribute more to the overall energy management and cost effectiveness than those they have been replacing since 1984. Tables 2.

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TESTING THE FLEXURE OF LARGE DIAPHRAGMS FOR FINAL LOW-PRESSURE STAGES OF STEAM TURBINES

Moscow ENERGOMASHINOSTROYENIYE in Russian No 7, Jul 86 p 45

[Article by V.S. Livshits, engineer]

[Abstract] Diaphragms for the final low-pressure stages of the K-1000-60/1500 low-speed turbine are large, outside diameter 5600 mm and inside diameter 2085 mm for the sixth stage, two halves welded together. They cannot be tested for flexure with the hydraulic press available at the "Turboatom" works, because it does not accomodate diaphragms larger than 3000 mm O.D. A special rig has therefore been built for this purpose, consisting of five hydraulic jacks arranged in a semicircle and connected by bent pipe segments. Each half of a diaphragm is placed, exhaust side down, on adjustable support wedges along the diaphragm perimeter. Pressure is applied with a GN-200M manual pump and measured with a manometer. This arrangement is recommended only for diaphragms larger than 3000 mm O.D. and for testing them under a total load not higher than 350 kN on one half. Figures 1; references 2: Russian.

2415/9835
CSO: 1861/35

UDC 658.52.011.56

THE "TURBINA" AUTOMATED SYSTEM FOR PRODUCTION PROCESS PLANNING

Moscow ENERGOMASHINOSTROYENIYE in Russian No 8, Aug 86 pp 47-48

[Article by L.I. Zaltsman, candidate of technical sciences, and engineers B.I. Beletskiy, Yu.V. Grigoryev, O.D. Rastovtsev, and V.V. Stepanov]

[Abstract] The "Turbina" automated system for production process planning, developed at the Tallinn Polytechnic Institute jointly with VPTIenergomash [All-Union Planning and Manufacturing Institute of Power Machinery] and the "Nevskiy Zavod" production association is a logical extenstion of the "Lopatka" [blade] system now in operation at the Leningrad Turbine Blade Manufacturing Plant. Its latest version is sufficiently universal to cover a wide range of parts and sizes. The revised software is faster and more reliable. The system consists of a monitor developed at the Institute of Cybernetics (ESSR Academy of Sciences), a database, and four functional subsystems: data search, database maintenance, parts and blanks description without limitation on the number of entries, and technological design. Reliability and speed are ensured by replacement of the DDM-F databank with the CETOP databank. The program language YaSM has been refined for more precise discriptions and for solution of any technological problem. Blueprints and specifications are generated upon activation of MODAPT and PAD-EC programs, with the aid of a format generator. The system has been introduced in the "Nevskiy Zavod", where it is now the only such system operating in the entire branch of industry. Tables 1; references 1: Russian.

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INCREASING EFFICIENCY AND RELIABILITY OF TURBINE STAGES WITH VANELESS GUIDE RING

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 86 pp 89-91

[Article by A.I. Sokolov, candidate of technical sciences, docent, and V.V. Chizhov, candidate of technical sciences, docent, 'Order of Lenin' and 'Order of October Revolution' Moscow Institute of Power Engineering]

[Abstract] Performance analysis of vaneless guide rings in small axial-flow, mixed-flow, and diagonal-flow turbines has revealed highly nonuniform circumferential and vertical distributions of flow parameters in the exit section. A new design of such a guide ring is proposed, therefore, which will reduce the attendant energy losses as well as the resulting transient forces acting

on the runner blades. The gist is lengthening the meridional section of the flow channel sufficiently deep into the volute cavity to ensure a uniform cross-section of its acceleration segment. A prototype of such a guide ring was tested, without and with jaws at various locations around the circumference. The results indicate a better performance, expecially with jaws, and its optimizability by design. Article was presented by Department of Steam and Gas Turbines. Figures 3; references 6: Russian.

2415/9835
CSO: 1861/56

UDC 621.438

EXPERIMENTAL STUDY OF HEAT TRANSFER IN MODEL COOLING CHANNELS FOR TURBINE BLADES

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 9, Sep 86 pp 92-95

[Article by A.S. Lebedev, engineer]

[Abstract] An experimental study of heat transfer in cooling channels for turbine blades was made, its purpose being a comparative evaluation of seven such channels with various types of interior heat transfer surfaces and intensifiers. The sample channels were mounted in an insulated test stand behind a stabilizing channel segment and heated by electric heaters with ribbon conductors. Measurements, made under steady-state conditions, included air flow rate, loss of total pressure head, temperature rise of air in the test channel, temperature of the heat transfer surface (arithmetic average of readings of 19 Chromel-Copel thermocouples), temperature of the main heater and protective heater as well as electric power drawn by each. The heat transfer coefficient was calculated from the data according to Newton's law, with the thermal flux determined calorimetrically (constant pressure), gradientally (across channel wall), or directly from the electric heating power. The flow parameters n and m in the dimensionless equation $N_{Nu} = mN_{Re}^{n}$ were also determined for each tested variant. Figures 3; references: 4 Russian.

2415/9835
CSO: 1861/56

HYPERBOLOID-86: REPORT FROM THE SYNCHROTRON RADIATION RESEARCH CENTER

Moscow PRAVDA in Russian 10 Jan 87 p 3

[Article by PRAVDA correspondent Ye. Solomenko in Novosibirsk under the rubric "Across the Country of Soviets": "Hyperboloid-86--Report from the SR [Synchrotron Radiation] Research Center"]

> [Text] The massive iron door with the scarlet trefoil warning of radiation danger opened up. There is no danger now, and we go up onto a small bridge suspended over the accelerator hall.

"There you go, there it is itself!" nodded my guide downward to a ten-meter elementary particle storage ring clad in metal armor. I already knew that there, under the armor, a vacuum reigns--as deep as that in outer space. And in this "cosmic" emptiness, directed and focused by powerful electromagnets and magnetic lenses, is borne a beam of particles of antimatter in a circle--positrons. They are borne at the speed of light along the closed storage tunnel, generating SR--synchrotron radiation.

We live in a sea of waves: every second we are "awash" in waves of visible light and those that cannot be seen--infrared, ultraviolet, X-rays and, finally, radio waves. And another one was discovered quite recently in this sea--synchrotron radiation.

It was revealed for the first time in the 1940s--in the synchrotron accelerators that were just appearing at the time. More than twenty years later, nuclear physicists from Novosibirsk under the guidance of the director of the institute at that time, Academician G. Budker, found a use for it--to compress beams of charged particles flying around in the accelerator and storage ring. But in the beginning of the 1970s, a second and very exciting life for SR began.

Before I went into the accelerator room, I visited the office of G. Kulipanov, a laboratory chief at the SR Institute of Nuclear Physics of the Siberian Branch of the USSR Academy of Sciences. Gennadiy Nikolayevich, not without some pride, showed me a somewhat strange booklet on the claret-colored cover of which was depicted... a photograph of a frog.

It seems that this goggle-eyed creature had become something of a co-author of the new and surprising research being conducted with the aid of SR. What happens in the molecules of a muscle when it contracts? Scientists had a very vague conception of this. Obtaining a photo at the molecular level required x-ray exposure times for the living tissue of a whole hour, while the contractions themselves lasted only a tenth of a second. The new radiation helped them obtain sixty-four exposures over this tenth of a second! The photographs that uncovered the molecular world within the working frog muscles make up this book, which was given to the researchers of the IYaF [Nuclear Physics Institute] by their generous colleagues from the Institute of Biophysics of the USSR Academy of Sciences near Moscow. At the time, in 1973, these were the first such photographs in the world.

The technique created to study living things also turned out to be valuable for materials science: the magic SR beam helped in taking new "films" of changes in the structure of materials in the processes of melting, rupture and chemical reactions.

The associates at the IYaF were not waiting for the next representative of the next scientific direction to hear about their miracle beam. They themselves sought out new customers. They came with specific proposals to the medical-science people there, and now they have created a fundamentally new type of diagnostics for cardiovascular disease. Gennadiy Nikolayevich extended a photograph:

"We took this picture of the circulatory system of a dog last year. See how clearly even the smallest three-millimeter vessels are imprinted? These "photomaps" are today obtained at only three institutions: at the Stanford SR Center in the United States, here at the IYaF and in Japan at the Tsukuba Photon Plant."

At the beginning of the 1960s, the nuclear physicists from Novosibirsk organized the first synchrotron radiation center in the country, based on their institute. This informal creative collective united associates from various institutes of the Siberian Branch of the USSR Academy of Sciences and scientists from Moscow, Sverdlovsk, Leningrad, Kiev, Yerevan and Vladivostok. Research groups are also working here from East Germany, Czechoslovakia, Hungary, India, England and France.

I stood on the iron bridge with the head of the center, Gennadiy Nikolayevich Kulipanov, while underneath us the SR beams were invisibly borne in the ring VEPP-2 storage ring. Metal pipes fanned out from the ring. These are the channels along which the beams pass to their "consumers" that are now nearby.

We left the accelerator room and looked in on one of the areas partitioned off from the storage ring by a three-layered wall of lead bricks. Here is the workstation of the experimental workers: the control panel and the table with a terminal hooked up to a computer. The display screen showed all information needed at the moment. The experimental worker, Ernst Dieter Klinkenberg, an intern from Rostock University, related:

"I am studying the isolation layers of semiconductors here. This institute is the only place where we can conduct such research."

In this same room, side by side with the young German scientist, worked someone from Novosibirsk from the Institute of Semiconductor Physics, a Leningrader from the State Optics Institute, a person from Sverdlovsk from Urals Polytechnical and researchers from Gorkiy and Prague. All of them are studying the properties of semiconductor materials. And alongside them geochemists are studying the composition of rock, meteorites and "moon rocks"--samples of lunar soil delivered to Earth--and medical researchers are subjecting blood and lymph tissue to similar analysis...

At one time the IYaF took up an enterprise that was unexpected for an academic institution: it began to produce commercial accelerators. Now another step has been taken here toward the merging of basic and applied research. A new organizational form has been found and tested--an interdepartmental collective-use research center. Here at the center, the most varied academic and sector organizations, breaking the infamous departmental barriers, combine their efforts to set up unprecedented experiments and to develop unique apparatus and the latest techniques and technologies. That is what the SR center is all about.

"SR! So what does it look like, this SR of yours? How about at least a peek at it?" I asked.

"A peek?" smiled Gennadiy Nikolayevich. "Sure, that's possible."

Coming down from the bridge, we go back up the stairs and press up against a glass window in the housing of the VEPP-2 storage ring. There it is, the synchrotron beam: an almost round spot of blue light, girdled with a yellow rim, above which blazed a red ring. A small round rainbow.

New SR generators without peer in the world have been developed and are already operating at the IYaF. Among them are a superconductive magnetic "snake" using the same VEPP-2. And the VEPP-2 is not, after all, the last trump.

We went three stories underground. There, a large round tunnel was visible through an illuminator in a blue door. Along the top of the tunnel, fastened to the roof, the massive lumps of electromagnets stretched around the circumference, smartly decorated in a bright blue color with two red stripes. This is the most advanced and powerful VEPP-3 storage ring, and its main "dance" takes place today in its 75-meter viscera, along which the electrons that give the invaluable beams to the researchers are borne.

Alongside, a room for the next experimental stations is being built. "New settlers" have already appeared in it by the new year.

But Gennadiy Nikolayevich tugged on my sleeve, attracting my attention nearer to the surface of the earth. Four meters above and we arrive in a quite gigantic circular tunnel. We are met by the master of this underground kingdom--the storage ring laboratory chief, I. Protopopov. He explains:

"Here we are reconstructing our champion--the VEPP-4. Whereas the VEPP-2 ring is ten meters and the VEPP-3 is seventy five, the length of this guy's ring is 360 meters."

Today the Novosibirsk nuclear physicists are helping with the creation of a second domestic SR center in Moscow. Next are other specialized installations that can be adapted for operations in plant or hospital conditions. Those who will be working with them are also training here as well.

And nonetheless, notwithstanding the clear and substantial successes, a stepped-up pace is essential to accelerate the development of this important scientific and technical area and speed up the creation of domestic SR centers.

"The third generation of SR sources is already being created abroad, and the start-up of the first such generator is proposed by 1992," says Academician A. Skrinskiy. "Here in the Soviet Union, the development of such apparatus has not even been put into planning yet. Moreover, the third-generation SR source is a very large center that cannot be created through the efforts of our institute alone. The most active assistance of the central departments and all interested sectors and departments is essential here: the Ministry of Geology, the Ministry of Non-Ferrous Metallurgy, the Ministry of Health, the Academy of Medical Sciences..."

We do not want to lose our leadership position. It simply cannot be. And as always, this depends not on one leader alone who does everything that he can, but on the ability to multiply his experience.

12821
CSO: 1861/111

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In this same room, side by side with the young German scientist, worked someone from Novosibirsk from the Institute of Semiconductor Physics, a Leningrader from the State Optics Institute, a person from Sverdlovsk from Urals Polytechnical and researchers from Gorkiy and Prague. All of them are studying the properties of semiconductor materials. And alongside them geochemists are studying the composition of rock, meteorites and "moon rocks"--samples of lunar soil delivered to Earth--and medical researchers are subjecting blood and lymph tissue to similar analysis...

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12821
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UDC [539.216.2:546.76-31]:535

LIGHT-MODULATING CHARACTERISTICS OF REFLECTING SELECTIVE ELECTROCHROMATIC DEVICES BASED ON AMORPHOUS P- AND N-TYPE SEMICONDUCTOR FILMS

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATEMATYCHNYKH NAVUK in Russian No 4, Jul-Aug 86 (manuscript received 25 Dec 85) pp 47-53

[Article by B.A. Budkevich, I.A. Ges, V.L. Malevich, V.A. Pilipovich, I.M. Romanov, and L.I. Romanova, Institute of Electronics, BSSR Academy of Sciences]

[Abstract] Use of the electrochromatic effect for modulation of light was studied on multilayer devices containing amorphous n-WO_3 and n-Cr_2O_3 films. Light was passed through two nearly identical electrochromatic devices A,B built on a common quartz substrate, each consisting of six films successively deposited at a temperature of 100°C: a transparent 115-150 nm thick In_2O_3:Sn film as lower electrode directly on the substrate, a four-layer WO_3 (500 nm thick) - SiO (0-15 nm thick) - Cr_2O_3 (120-180 nm thick) - La_2O_3 (200 nm thick) structure on that electrode and extending beyond directly on the substrate (the La_2O_3 film and not extend into the path of the light beam), and a specularly reflecting Au film as upper electrode which was 30 nm thick in device A for measuring the kinetics of the transmission coefficient and 200 nm thick on device B for measuring the kinetics of the reflection coefficient. The films were deposited by various methods: In_2O_3:Sn films by ion-plasma sputtering of an In+ 9% Sn target in an Ar+ O_2 atmosphere, WO_3 and SiO films by vacuum evaporation from a W wire, Cr_2O_3 and La_2O_3 films by evaporation of Cr and La in a O_2 atmosphere under a total pressure of 0.01-1 Pa at rates of 0.1-1 nm/s both, and Au films by vacuum evaporation from a Mo wire. The role of the La_2O_3 film, not participating in the electrochromatic effect, was to provide electrical insulation between electrodes during the coloration process. Measurements were made with light of the λ=632.8 nm wavelength normally incident from the substrate side upon application of square voltage pulses of up to $\pm$2 V amplitude and 100-600 ms duration. Measurements included the transmission coefficient and the reflection coefficient as functions of time, the contrast in each mode as a function of the voltage, and in the reflection mode also the contrast as a function of the change in optical density of the WO_3 film. The optical contrast and the Fresnel coefficient was also calculated for debice B, assuming a negligibly thin SiO film. Evaluation of the

experimental data and theoretical analysis indicate that a high optical contrast is attainable with a reflecting structure such as device B, depending on the thickness of the In_2O_3:Sn electrode-film, but its voltage characteristics become nonlinear and sharply peaking. Use of such a device for modulating light in space is nevertheless feasible, inasmuch as the optical contrast rises very steeply and almost linearly to its maximum as a function of the control voltage. K may be as high as 150 when the induced optical density ΔD is 0.65. Figures 3; references 12: 5 Russian, 7 Western (2 in Russian translation).

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CSO: 1861/58

UDC 551.463.5:535.36

SIGNAL-TO-NOISE RATIO DURING PROBING OF OBJECTS WITH LIGHT PULSES IN SCATTERING MEDIUM

Minsk VESTSI AKADEMII NAVUK BSSR: SERYYA FIZIKA-MATEMATYCHNYKH NAVUK in Russian No 4, Jul-Aug 86 (manuscript received 25 Oct 85) pp 53-58

[Article by A.I. Kolesnik and A.P. Ivanov, Institute of Physics, BSSR Academy of Sciences]

[Abstract] Probing of objects with light pulses in a turbulent multiply-scattering medium is considered, taking into account diffuseness of light pulses in time. Assuming that a light pulse with energy W_0 is emitted by a source whose power varies in time and is received by a device such as a photodetector or an image converter with time scan, a simple expression for the signal-to-noise ratio is derived analytically on the basis of a model of shot noise with interference in the form of clutter. A two-parametric incomplete gamma distribution approximates most closely the real distribution of time spread of a δ-pulse along its source-object-receiver path through the medium, and the resulting expression for the signal-to-noise ratio is sufficiently accurate for engineering purposes. Figures 1; references 7: Russian.

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CALCULATION OF THREE-DIMENSIONAL STATIONARY TURBULENT BOUNDARY LAYER ON ROOT SECTION OF WING IGNORING COMPRESSIBILITY

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 25 Mar 85) pp 72-76

[Article by G.A. Shchekin]

[Abstract] A method for calculating a three-dimensional steady-state turbulent boundary layer was proposed. It is based on a general method for calculating three-dimensional compressible laminar and turbulent boundary layers on arbitrary wings, proposed by T. Cebeci et al. Boundary conditions on the surface and on the external boundary of the boundary layer were formulated. In the transition region, the coefficient of turbulent viscosity increases in direct proportion to the longitudinal coefficient of intermittency. After transformations, the initial set of equations was solved numerically, using Petukhov finite differences method. For solving the set of equations on a computer, a program, written in the FORTRAN language, was developed. Components of the local coefficient of friction resistance, projected onto the chord and wing span directions, the displacement thickness of the three-dimensional boundary layer and the boundary of the separation region were calculated. Expressions for calculating these parameters were presented. In the process of calculations, the influence region and the dependence region were determined in each design point. This made it possible to determine accurately enough the boundary of the off-design region, i.e. the region, where the boundary layer equations are not parabolic anymore and where the necessary condition for existence of a solution is violated. Generally speaking, the boundary of the off-design region does not have to coincide with the boundary of the separation region. However, the author had found earlier that the boundary of the off-design region, determined in the process of calculating a laminar three-dimensional stationary boundary layer, and the boundary of the experimentally found separation region were in good agreement. As an example, calculations of a three-dimensional stationary turbulent boundary layer on the top surface of the root section of a swept wing were performed in accordance with the proposed method. The results of calculations were compared to data, obtained earlier by J.P.F. Lindhout et al. Figures 4, references 6: 2 Russian, 4 Western.

12770
CSO: 1861/343

UDC 533.6.011.34:629.7.025.1

CALCULATION OF AERODYNAMIC CHARACTERISTICS OF THREE-DIMENSIONAL FINITE SPAN WINGS IN POTENTIAL INCOMPRESSIBLE FLOW

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 25 Jun 84) pp 43-48

[Article by S.D. Yermolenko and Ye.A. Ryaguzov]

[Abstract] A simpler and less time-consuming method for solving the problem was offered. It was based on application of the discrete vortex method which earlier proved to be effective in solving two-dimensional problems. A non-separating potential incompressible flow was examined under the assumption that the wing surface was specified, wherein the left-hand side of the wing was symmetrical to its right-hand side, its leading and trailing edges were straight, its ends were flat and there was no slippage. Wing profile could vary across the span and had a geometric twist. The method for constructing a vortex model was explained. Intensities of vortices were determined. Knowing geometric parameters of the vortex model and intensities of vortices, comprising it, formulae for reduced flow velocity and static pressure coefficient in reference points were derived. After the above parameters had been determined, one could calculate lift and drag coefficients and the pitch moment, first for reference sections and then for the wing as a whole. Examples of pressure distribution in the root, end and mid-sections of thick wings, calculated in accordance with the proposed method and other authors' methods were presented; these results were compared to results of wind tunnel tests of these wings. Design and experimental data were in good agreement. It was noted that calculations according to the proposed method were conducted on a less powerful YeS 1033 computer. Figures 4; references 4: 3 Russian, 1 Western.

12770/9835
CSO: 1861/343

UDC 532.59

TRANSFORMATION AND REFRACTION OF SURFACE WAVES

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 2, Apr 86 (manuscript received 11 Sep 84) pp 42-47

[Article by Yu.Z. Aleshkov]

[Abstract] Propagation of waves on the surface of a liquid, an important problem in marine engineering, is treated analytically including the effect of a nonuniform depth of the liquid layer. Motion of an ideal homogeneous incompressible fluid is considered in a Cartesian system of coordinates. The

problem of propagating surface waves, formulated here in the linear approximation, is to determine the velocity potential $\phi^0(x,y,z_1,t)$ which satisfies the equation $\partial^2\phi^0/\partial x^2 + \partial^2\phi^0/\partial y^2 + \phi^0_{z_1z_1} = 0$ with $z_1 = -H_1(x,y)$ denoting the depth of the liquid layer between the horizontal free surface and the uneven bottom. This problem is solved, for the appropriate boundary conditions, by the method of characteristics and with the aid of the solution to the Cauchy problem for the corresponding system of ordinary differential equations, assuming that the liquid oscillates at a given frequency. References 5: 4 Russian, 1 Western.

2415/9835
CSO: 1861/18

UDC 533.6.011

SOME ASYMPTOTIC MODES OF TRANSONIC VORTEX FLOW

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA, SERIYA 1: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 2, Apr 86 (manuscript received 15 Mar 83) pp 61-65

[Article by A.G. Kuzmin]

[Abstract] Plane-parallel vortex flow of an ideal gas is analyzed, assuming a flow sufficiently smooth for the velocity near a point on the sonic line to be $v/a_* = \lambda(x,y) = 1 + \lambda_{10}\phi + \lambda_{01}\psi + \lambda_{02}\psi^2 + \ldots$ (v- velocity of gas, a_*- critical acoustic velocity, $\psi(x,y)$ - flow function, $\phi(x,y)$ = const - lines orthogonal to stream line, λ_{10}, λ_{01}, λ_{02} - constants). The corresponding system of equations of gas dynamics is formulated and solved under the contraint that $\lambda_{02} = 0$. Flow patterns in the vicinity of two points on the sonic line are examined: point K at which the sonic line is normal to the velocity vector and the acceleration is finite ($\lambda_{01} = 0$, $\lambda_{10} \neq 0$), and point N at which the acceleration is zero ($\lambda_{01} = \lambda_{10} = 0$). These patterns are based on the solution in accordance with two theorems, both of which are proved here. All possible modes of vortex flow in the vicinity of point K, and some modes of vortex flow in the vicinity of point N are indicated. Figures 4; references 12: all Russian.

2415/9835
CSO: 1861/18

UDC 533.6.011.55

CONICAL WING WITH MAXIMUM LIFT-TO-DRAG RATIO IN SUPERSONIC GAS FLOW

Moscow IZVESTIYA AKADEMII NAUK SSSR MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 3, May-Jun 86 (manuscript received 6 Mar 85) pp 128-133

[Article by V.I. Lapygin and P.V. Tretyakov, Moscow]

[Abstract] Analysis of the flow of air around a delta wing yielded equations for the coefficients of normal force on the upwind and downwind edges in a previous article by these authors. These equations were used to determine the transverse cross-sectional shape of an optimal delta wing using linear flow theory or function approximations. It turns out that maximum lift-to-drag ratio is achieved in a wing with a flat lower surface. Simple analytic equations are presented determining the aerodynamic coefficients of a wing for angles of attack up to the point of separation of the leading shock wave from the leading edge. Figures 5; references 9: 7 Russian, 2 Western.

6508/9835
CSO: 1861/5

UDC 532.526.013.4

EXCITATION OF NATURAL OSCILLATIONS OF A BOUNDARY LAYER BY AN EXTERNAL ACOUSTIC FIELD

Moscow IZVESTIYA AKADEMII NAUK SSSR MEKHANIKA ZHIDKOSTI I GAZA in Russian
No 3, May-Jun 86 (manuscript received 11 Jun 85) pp 74-78

[Article by A.A. Maslov and N.V. Semenov, Novosibirsk]

[Abstract] A previous work demonstrated the possibility of creating a source of deterministic acoustic excitation based on a discharge-boundary layer system and studied the field of radiation from the source. Using this same source, the present article undertakes for the first time experimental studies of the susceptibility of the supersonic boundary layer to undergo the transition from laminar to turbulent flow. It was found that there are areas on the plate of most effective conversion of external acoustic disturbances to natural oscillations of the supersonic boundary layer. The leading edge of the plate, acoustical branch of the neutral curve and lower branch of the curve of neutral stability are such areas. Experiments were performed in a T-325 supersonic wind tunnel at the Institute of Theoretical and Applied Mechanics of the USSR Academy of Sciences Siberian Branch with reduced turbulence in a 200 x 200 mm cross-section. The incident stream was at Mach number M = 2.0 and (utilized) Reynold's number was varied between 5×10^6 m^{-1} and 12×10^{-6} m^{-1}. Figures 4; references 11: 9 Russian, 2 Western.

6508/9835
CSO: 1861/5

UDC 533.6.011.5:519.63

NUMERICAL STUDY OF SUPERSONIC FLOW AROUND BLUNT BODIES WITH EXTENDED NEEDLE NOSE

Moscow IZVESTIYA AKADEMII NAUK SSSR MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 86 (manuscript received 21 May 85) pp 119-127

[Article by V.N. Karlovskiy and V.I. Sakharov, Moscow]

[Abstract] A method has been developed for calculation of the supersonic flow of an ideal gas around axisymmetrical blunted bodies with extended needle nose. A study is made of the flow around a truncated cone with a spherical blunted cylindrical needle as a function of the ratio of needle length to diameter of the end portion of the body and Mach number of the incident stream. Several steady flow modes are obtained, including one with circulation zones in the shock layer and internal shock wave. The installation of a needle in advance of the truncated cone can reduce its resistance by 40 to 50%. A full study of the change in drag as a function of ratio of needle length to diameter of the end of the body is performed for Mach 3. Figures 6; references 19: 12 Russian, 7 Western.

6508/9835
CSO: 1861/5

UDC 621.671:532.528

DYNAMICS OF REVERSE FLOWS AT PUMP INLET

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 14 May 85) pp 49-53

[Article by N.S. Yershov]

[Abstract] Multimode aircraft engines inevitably operate in reverse flow modes. Earlier the author had proposed an equation, describing the field of axial velocity components in the reverse flow region of a pump inlet. The length of reverse flows in static conditions was determined. A function that describes the field of axial components of velocity was derived. Under stationary conditions, due to the effect of cavitation on the aerodynamics between the blading and the flow, the length of the zone of reverse flows decreases and the field of velocities in each section is distorted. The boundary of reverse flows is a place where the reverse flow and an unperturbed flow meet at the inlet pipe wall. An equation was derived that gives mathematical description of a phenomenon which was observed in the case of self-excited oscillations, when at a certain stage of the process the length of reverse flows increases. This phenomenon was in contradiction with earlier conceptions. The derived equations could be used for construction of a dynamic model of a pump, operating with reverse flows. Figures 2; references 5: 4 Russian, 1 Western.

12770/9835
CSO: 1861/343

UDC 621.774.77

CALCULATION OF WALL THINNING DURING EXPANSION OF MIDDLE PORTION OF PIPE SUBJECTED TO LIQUID OR GAS PRESSURE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 12 Dec 84) pp 67-72

[Article by A.S. Chumadin]

[Abstract] The process of expansion of the middle portion of a tube with restrained and free edges was analyzed. The method for calculation of wall thickness distribution along the radius of the produced shell that uses numerical integration of a differential equation was presented. The problem was solved in accordance with the momentless theory of shells, using St. Venant plasticity conditions and linear approximation of reinforcement diagram in "yield stress - logarithmic deformation" coordinates. The effect of contact friction against the surface of a die was disregarded. The process was considered approximately monotonic. An expression was derived that makes it possible to determine shell wall thickness as a function of the running radius. Analysis of the equation demonstrated that this dependence is a general function of thickness distribution along the shell generating line, regardless of the type of edge restraint. Calculations in accordance with the proposed method were conducted on an SM-4 computer. These calculations made it possible to determine theoretical distribution of shell thicknesses, produced by expanding a pipe (diameter 30 mm, wall thickness 0.75 mm, material - D16M) with free and restrained edges. Results of the calculations and experimental data were plotted and compared. The error in determining the thickness did not exceed 3%. Comparison with data, obtained by other authors, showed deviations of not more than 5-7% at deformation degrees not exceeding 0.2. It was noted that pipe shape during expansion differs from the shape of the surface, generated by rotating an arc of a circle, and that the process can only be considered monotonic at low degrees of deformation. It was therefore suggested that the proposed method and relations could be employed for analyzing expansion processes with deformation degrees not exceeding 0.25-0.30. Figures 3, references: 4 Russian.

12770
CSO: 1861/343

UDC 539.4:629.7.02

SOLUTION OF GEOMETRICALLY NONLINEAR PROBLEM FOR REINFORCED SHELL OF REVOLUTION HAVING ARBITRARY SHAPE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 29 Dec 84) pp 53-59

[Article by V.V. Kuzmin]

[Abstract] A discrete energy method (DEM) for solving geometrically nonlinear problems was presented. This method is claimed to be more economical, in terms of computer memory, than standard finite element or finite differencing schemes and is not inferior to the orthogonal run method. When the DEM is used, various boundary conditions of problems are met more simply. A thin elastic shell, reinforced with frames and rings around central cut-outs and subjected to an arbitrary axial-symmetric surface load and to various axially-symmetric contour loads, was examined. The following factors were taken into account: eccentricity of reinforcements in relation to shell surface, variable thickness, possible use of different materials for different shell sections, difference of stiffness characteristics of frames and rings relative to each other, the arbitrary number and uneven pitch of frames, the accuracy of lines of a double curvature shell. The problem was reduced to solving a mathematical programming problem. A function for solving this problem was derived. It was proposed to use the Polack-Ribier method [MPR] for minimization of this function, as it is more stable numerically than the Fletcher-Reeves method. The MPR also has advantages, compared to other direct minimization methods. Using the DEM, behavior of a hinge-supported shell structure in a supersonic flow was examined. Fields of normal and meridional displacements along the meridian arc, measured from the cut-out edge, and maximum values of stresses, derived according to the linear and nonlinear theories, were examined. Using a series of nonlinear calculations in the case of increasing load, the load of axially-symmetrical shell bulge shape was determined. One verification test of the truthfulness of results, derived with the help of DEM, was a nonlinear analysis of a smooth hinge-supported cylindrical shell, made of titanium and subjected to compression along the generating line. Figures 3; references 8: 6 Russian, 2 Western.

12770/9835
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UDC 539.4:629.7.02

RATIONAL REINFORCEMENT OF CYLINDRICAL SHELLS WITH VARIABLE STIFFNESS FRAMES SUBJECTED TO EXTERNAL PRESSURE

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 5 Jan 84) pp 29-33

[Article by A.S. Gorbatov and Yu.M. Pochtman]

[Abstract] The problem of optimum design of hinged orthotropic cylindrical shells, reinforced with variable stiffness frames and subjected to external pressure was reduced to a nonlinear programming problem. Shell volume was chosen as otpimization criterion. Equations for a mathematical optimization model were derived. The moment character of the subcritical state and the discrete character of the reinforcement were taken into account. The model was realized as a program on a YeS-1050 computer. A quantitative experiment on choosing optimum parameters was conducted for cylindrical fiberglass shells (L/R = 1.0), reinforced with 10 frames with rectangular cross-section, evenly distributed along the shell generating line. The reinforcement was symmetrical in relation to the center of the generating line. By only varying frame heights, it was possible to save 14.8% of materials, compared to the original design with constant frame height. Optimum designs were also received for steel shells. By varying frame stiffness, shell volume was reduced by 8%. Comparison of three types of reinforcement (I- constant stiffness shells; II- variable stiffness shells; III- variable stiffness and frame pitch shells) demonstrated that efficiency of type II was 6% and that of type III is 13% higher than that of type I. The proposed model of optimization of reinforced shells, based on the specialized search algorithm of conditional minimization, makes it possible, unlike in the case of a simple exhaustive search method, to define the strategy for improving efficiency, as far as volume of shells of a given class is concerned, in an automatic or interactive (between a computer and a decision maker) modes. Efficiency of the optimization model improves as the number of variable parameters increases. References: 4 Russian.

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CSO: 1861/343

UDC 539.3:629.7.02

FINITE DEFORMATIONS OF SHELL WITH RIGID INCLUSION

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 27 Feb 85) pp 3-7

[Article by B.A. Antufyev]

[Abstract] An approximate solution of the problem of deformation of a radially loaded flexible shell with non-negative gaussian curvature that has a rigid inclusion of an arbitrary shape was sought. A sloping, rectangular in the top view model of a shell panel, reinforced by means of a rigid inclusion, the size of the latter being small compared to the panel radii of curvature, was examined. The system was loaded with a distributed normal load. Nonlinear deformation of the panel was described by equations of the theory of flexible sloping shells. Displacements of the rigid inclusion were determined by the shift and angles of rotation relative to coordinate axes. The problem was reduced to a set of equations, consisting of two nonlinear differential equations of a flexible shell, three integral inclusion equilibrium equations and two shell and inclusion compatibility equations. The unknown quantities were normal displacements, the shell stress function, two interaction reactions and three constants. The set of nonlinear equations was solved, using the successive approximation method and the Bubnov method, thus reducing the problem to solving linear algebraic equations. The process of solving nonlinear equations as a sequence of linear problems was successively repeated until solutions of two successive approximations coincided with a given degree of accuracy. As an example, a spherical shell, hinge supported by non-stretchable ribs, flexible in the tangent plane, that was loaded with a radial force via a rigid square inclusion, located in the center of the panel, was examined. Relations between a dimensionless radial force and shell displacement at the load point for a smooth shell and a shell with an inclusion were calculated. The curve for a smooth shell satisfactorily matched theoretical and experimental results, obtained by others. Figures 2, references 6: 4 Russian 2 Western.

12770
CSO: 1861/343

UDC 539.431

FATIGUE FAILURE OF THIN POROUS STRIPS

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR Vol 124, No 1, Oct 86 (manuscript received 19 Oct 84) pp 49-51

[Article by G.G. Gugunishvili, G.V. Kiziriya and L.I. Rozentur of the Scientific Research Institute of Electron-Ion Technology NIIET in Tbilisi and the Georgian SSR Academy of Sciences Institute of Structural Mechanics and Seismic Stability under the rubric "Mechanics": "Fatigue Failure of Thin Porous Strips"; presented by Academy Corresponding Member Sh.G. Napetvaridze on 1 Oct 84]

[Text] Fatigue-strength research on materials occupies quite a bit of time as a consequence of the extremely large number of loading cycles needed for the failure of the specimens being tested. Therefore, a comparatively rapid forecast of strength properties using a relatively small quantity of research data is topical.

This work is devoted to researching the fatigue failure of thin (about 10^{-4} meters [m]) porous plates depending on the number of cycles needed for the specimen to fail, its geometric dimensions and the amount of stress applied.

The experimental part was executed on the installation described in work (1). The specimens were thin drawn strips of bands obtained from the rolling of mixtures consisting of PNK-1 powdered nickel and finely ground (particle radius about 1×10^{-6} m) $Ni(NO_3)_2\ 6H_2O$ salt in a ratio of 9:1 with subsequent sintering in a hydrogen atmosphere for 1 hour at a temperature of 1,023 degrees Kelvin. The longitudinal axis of the specimen coincided with the direction of the band rolling. One end of the strip was fastened and the other was deflected measurably in both directions. We were limited in practice by the important case of the small deviation of the moving end of the strips, where the number of cycles needed for the failure of the specimen was especially great. The stresses that arise therein are not great and the relationship between the stresses and the deformations can be expressed in linear fashion.

$$\frac{\partial^2 v(z)}{\partial z^2} = \frac{M(z)}{EJ_x} \quad (1)$$

where v(z) is the deviation of points on the longitudinal axis of the strips; M(z) is the bending moment; E is the modulus of elastiscity and J_x is the axial cross-sectional moment of inertia.

One and the same frequency of loading was used in the experiments for all specimens--24 cycles per second--so that the dependence of fatigue strength on the frequency of deviation for subsequent debate is inconsequential.

It should be noted, however, that the dependence on the frequency of loading is associated chiefly with the magnitude of the ratio $\varepsilon_1/\varepsilon_2$, see (2), where ε_1 is the voltage imparted to the test specimen in each cycle, proportional to the area of the hysteresis loop on the coordinates σ-ε (stress-deformation); and ε_2 is the convective heat transfer from the surface of the specimen per unit time.

Measurements showed that the surface temperature of the specimens at frequencies of about 10^1 cycles/second are within the range of daily fluctuations, and therefore the effect of frequency on the temperature of the specimen in this case can be ignored.

We used two bands for the manufacture of the experimental specimens: one $180 \pm 5 \times 10^{-6}$ m thick with an average porosity of 21 percent and the other $300 \pm 5 \times 10^{-6}$ m thick with an average porosity of 35 percent. Both specimens had the same length of $l = 0.04$ m.

According to the test results, histograms of the absolute frequencies of the number of cycles for failure, as well as the corresponding dispersion, were constructed. A test series of 300 identical specimens was conduced to construct each histogram. Fig. 1 presents a typical histogram. The test results are presented in the table, from which it is apparent that according to the measurement results, the number of cycles until the failure of specimens with a given value for the constant $c=\frac{bh}{l}\cdot V_l$ can, with a precision suitable for practice, be predicted by the average number of cycles and other statistical instances for the specimens of the same material with the same value of c, but with varying values for b, k, l and V_l, where l, b and k are the length, width and thickness of the plate and V_l is the maximum deviation of the free end.

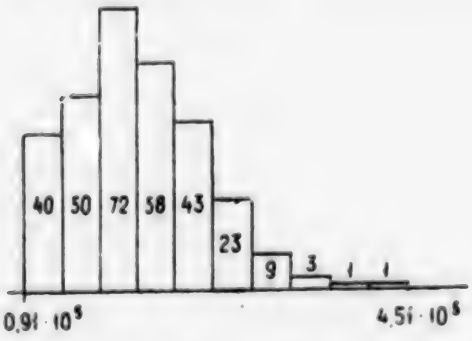

Fig. 1. Histogram of the number of cycles for failure in fatigue testing of nickel specimens with a porosity of 20-22 percent, thickness of 18×10^{-5} m, width of 0.02 meters and free-end deviation of 0.002 m.

Results of Testing Experimental Specimens for Resistance to Fatigue

V_f, м	b, м	c, м³	(1) Образцы толщиной h=0,00018		(2) Образцы толщиной h=0.000300	
			$10^{-5}\cdot\overline{N}$	10^{-5} DN	10^{-5} N	10^{-5} DN
0,001	0,04	$4\cdot10^{-5}$	2,62	0,93	0,84	0,22
0,002	0,02		1,96	0,61	0,47	0,15
0,001	0,02	$2\cdot10^{-5}$	3,74	0,87	0,88	0,26
0,002	0,01		3,15	0,82	0,79	0,29

Key: 1--Specimen thickness h = 0.00018; 2--specimen thickness h = 0.000300.

Precis: MECHANICS

G.G. Gugunishvili, G.V. Kiziria, L.I. Rozentur

FATIGUE DESTRUCTION OF THIN POROUS PLATES

Summary

Some problems concerning the fatigue destruction of thin (about 10^{-4} m) porous plates depending on the number of cycles necessary for specimen destruction, its geometrical shape and the voltage applied have been investigated.

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12821
CSO: 1861/112

UDC 539.3

OPTIMAL RIBBING OF LONG PLATE MADE OF COMPOSITE MATERIAL

Yerevan DOKLADY AKADEMII NAUK ARMYANSKOY SSR in Russian Vol 82, No 5, 1986 pp 214-217

[Article by E.V. Belubekyan and A.Z. Darbinyan, Yerevan Polytechnical Institute imeni K. Marx]

[Text] Let a long rectangular plate of width b be strengthened by means of equidistant stiffening ribs, be hinged along edges $y = 0$ and $y = b$, and be subjected to transverse pressure of $q = q(y)$ (cf. figure). It is assumed that the construction is made of monolayers of a VKM [composite fibrous material] alternately placed at an angle of $\pm \phi$ to the x axis in the plates between the ribs, and along the y axis in the ribs.

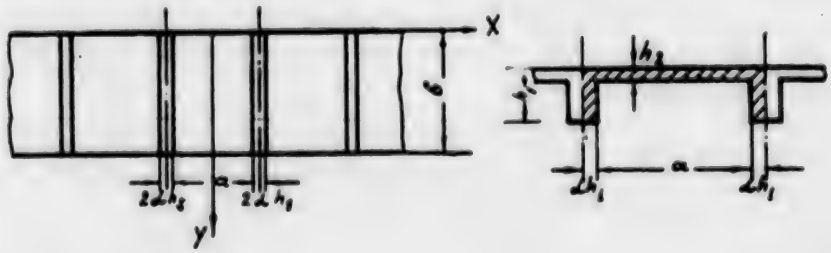

Figure 1.

The problem is presented of determining the values of h_1, h_2, α, a and ϕ such that the construction will have the greatest supporting power while its weight and strength constraints are preserved. The condition

$$a = \frac{2\alpha h_1 (h_1 - h_0)}{h_0 - h_2}, \tag{1}$$

where h_0 is the thickness along a continuous length of a plate of a given weight, ensures constancy of the construction's weight.

In view of the equidistance of the ribs, the problem is examined of the strength of an orthotropic plate of dimensions a x b , supported along edges $x = \pm a/2$ on elastic beams.

The plate's deflection function, w , must satisfy the equation

$$D_{11}\frac{\partial^4 w}{\partial x^4}+2D_3\frac{\partial^4 w}{\partial x^2\partial y^2}+D_{22}\frac{\partial^4 w}{\partial y^4}=q \tag{2}$$

and the boundary conditions

$$\begin{aligned} &w=0,\quad \frac{\partial^2 w}{\partial y^2}=0 \quad \text{with} \quad y=0,\quad y=b,\\ &\frac{\partial w}{\partial x}=0,\quad \frac{\partial^3 w}{\partial x^3}=0 \quad \text{with} \quad x=0,\\ &\frac{\partial w}{\partial x}=0,\quad D_{11}\frac{\partial^3 w}{\partial x^3}+ah_1 q=E_1 J\frac{\partial^4 w}{\partial y^4} \text{ with} \quad x=\frac{a}{2}, \end{aligned} \tag{3}$$

where

$$D_{1k}=\frac{B_{1k}h_1^3}{12},\quad D_3=D_{12}+2D_{66}.$$

$J = h_1^4/12$ is the moment of interia of half the stiffening rib in terms of weight, E_1 is the modulus of elasticity of the VKM along the fibers, and B_{1k} represents the elastic characteristics of the VKM monolayers along the x axis, determined through their elastic characteristics, B^0_{1k} , along the direction of the fibers from the familiar deflection formulas in [1].

By expanding the loading function into a Fourier series,

$$q(y)=\sum_1^\infty a_k\sin\lambda_k y,\quad a_k=\frac{2}{b}\int_0^b q(y)\sin\lambda_k y\,dy,\quad \lambda_k=\frac{\pi k}{b},$$

we find a solution to (2) while satisfying conditions (3) for three possible cases:

$$D=D_3^2-D_{11}D_{12}>0,\quad D<0,\quad D=0.$$

The solution just for the case of $D < 0$ is presented here for the sake of brevity:

$$w=\sum_1^\infty\left[\frac{a_k}{D_{22}\lambda_k^4}+A_k\operatorname{sh}\beta_1\lambda_k x\sin\beta_2\lambda_k x+B_k\operatorname{ch}\beta_1\lambda_k x\cos\beta_2\lambda_k x\right]\sin\lambda_k y, \tag{4}$$

where

$$\beta_{1,2}=\sqrt{\frac{\sqrt{D_{11}D_{22}}\pm D_3}{2D_{11}}},$$

$$A_k=-\frac{2a_k}{C_kD_{11}\lambda_k^3}\left(\frac{E_1J}{D_{22}}-ah_1\right)\left(\beta_2\mathrm{ch}\beta_1\frac{\lambda_k a}{2}\sin\beta_2\frac{\lambda_k a}{2}-\beta_1\mathrm{sh}\beta_1\frac{\lambda_k a}{2}\cos\beta_2\frac{\lambda_k a}{2}\right),$$

$$B_k=-\frac{2a_k}{C_kD_{11}\lambda_k^3}\left(\frac{E_1J}{D_{22}}-ah_1\right)\left(\beta_1\mathrm{ch}\beta_1\frac{\lambda_k a}{2}\sin\beta_2\frac{\lambda_k a}{2}+\beta_2\mathrm{sh}\beta_1\frac{\lambda_k a}{2}\cos\beta_2\frac{\lambda_k a}{2}\right),$$

$$C_k=4\beta_1\beta_2(\beta_1^2+\beta_2^2)\left(\mathrm{sh}^2\beta_1\frac{\lambda_k a}{2}+\sin^2\beta_2\frac{\lambda_k a}{2}\right)+\frac{E_1J}{D_{11}}\lambda_k(\beta_1\sin\beta_2\lambda_k a+\beta_2\mathrm{sh}\beta_1\lambda_k a).$$

The strength conditions are arrived at in the form of:

$$\sigma_{ymax}\leqslant\sigma_{B1}\quad\text{for a rib,}\tag{5}$$

$$\left(\frac{\sigma_{11}}{\sigma_{B1}}\right)^2+\left(\frac{\sigma_{22}}{\sigma_{B2}}\right)^2+\left(\frac{\sigma_{12}}{\tau_{B0}}\right)^2-\frac{\sigma_{11}\sigma_{22}}{\sigma_{B1}^2}\leqslant 1\tag{6}$$

for the most unsafe points of the plate.

Here σ_{B1}, σ_{B2} and τ_{B0} are the strength characteristics of the VKM, σ_{ymax} is the maximum stress in the rib, determined by the formula

$$\sigma_{ymax}=-E_1\frac{h_1}{2}\frac{\partial^2 w}{\partial y^2}\quad\text{with}\quad x=\frac{a}{2},\quad y=\frac{b}{2},\tag{7}$$

σ_{11}, σ_{22} and σ_{12} are the stresses in the most unsafe points of the plate ($x = 0$, $y = b/2$, $z = h_2/2$ and $x = a/2$, $y = b/2$ and $z = h_2/2$) along the directions in which the VKM monolayers are laid, where

$$\sigma_{11}=B_{11}^0e_{11}+B_{12}^0e_{22},\quad \sigma_{22}=B_{12}^0e_{11}+B_{22}^0e_{22},\quad \sigma_{12}=B_{66}^0e_{12},\tag{8}$$

and e_{11}, e_{22} and e_{12} are the strains along the directions in which the VKM monolayers are laid, which by the formulas

$$e_{11}=e_x\cos^2\varphi+e_y\sin^2\varphi-e_{xy}\sin\varphi\cos\varphi,$$

$$e_{22}=e_x\sin^2\varphi+e_y\cos^2\varphi+e_{xy}\sin\varphi\cos\varphi,$$

$$e_{12}=(e_x-e_y)\sin 2\varphi+e_{xy}\cos 2\varphi$$

are expressed in terms of strains along the directions of axes x and y :

$$\varepsilon_x = -z\frac{\partial^2 w}{\partial x^2}, \quad \varepsilon_y = -z\frac{\partial^2 w}{\partial y^2}, \quad \varepsilon_{xy} = -2z\frac{\partial^2 w}{\partial x \partial y} \tag{9}$$

with $x = 0$, $y = b/2$, $z = h_2/2$ and $x = a/2$, $y = b/2$ and $z = h_2/2$.

With an assigned distribution of the load, q(y), in accordance with formulas (7) and (8), the stresses at the most unsafe points of the rib and plate are computed, and then the respective values of the loading parameter, q_{01}, q_{02} and q_{03}, are determined from strength conditions (5) and (6). The safe supporting power will be

$$q_0 = \min\{q_{01}, q_{02}, q_{03}\}. \tag{10}$$

With an assigned weight of the construction (h_0) and also with a value of $\alpha = 0.1$, which according to beam design theory corresponds to the limiting value of the ratio of a rib's width to its height (1/5), parameter q_0 is determined by the values of the height of the rib, h_1, the thickness of the plate, h_2, and the angle at which the VKM monolayers are laid, ϕ. The maximum value of q_0 should be reached by the optimal choice of these values.

The problem raised reduces to the following problem in nonlinear programming:

Find

$$Q = \max_{\bar{x}} \bar{q}_0, \quad x = \{\bar{h}_1, \bar{h}_2, \varphi\} \tag{11}$$

under the constraints

$$\bar{h}_2 \leqslant \bar{h}_1 \leqslant 0{,}2; \quad \delta \leqslant \bar{h}_2 \leqslant \bar{h}_0; \quad 0 \leqslant \varphi \leqslant \frac{\pi}{2}; \quad \bar{a} \geqslant 5\bar{h}_2. \tag{12}$$

Here $q_0 = q_0/q_{B1}$ is an objective function, q_0 is determined from (10), $\bar{x}$ is the control vector, and $\bar{h}_1 = h_1/b$, $\bar{h}_2 = h_2/b$, $\bar{a} = a/b$ and $\bar{h}_0 = h_0/b$ are the geometrical parameters of the construction.

Constraints (12) are due to the limits of applicability of the classical theory of beams and plates. The values of parameter δ are assumed to be $\delta = 0.01$ when $a \geq b$, and $\delta = 0.01\bar{a}$ when $a < b$.

The problem is solved by means of the complex random search procedure developed by (Boks) [2]. A numerical solution was obtained for a plate made of SVAM 5:1 [anisotropic glass-fiber material].

The values obtained for optimal parameters ϕ, $\bar{h}_1$ and $\bar{h}_2$, the corresponding spacing between ribs, $\bar{a}$, and the corresponding maximum supporting power, Q, for various weight characteristics, $\bar{h}_0$, are presented in the table. The values of the maximum supporting power, Q_0, for individual continuous plates ($\phi = 90$ deg) are also given for comparison.

Table

$\bar{h}_0$	φ^0	$\bar{h}_1$	$\bar{h}_2$	$\bar{a}$	Q	Q_0
0,05	88	0,193	0,0178	0,171	0,00915	0,00339
0,04	86	0,168	0,0146	0,170	0,00625	0,00216
0,03	86	0,144	0,0113	0,163	0,00382	0,00122
0,02	87	0,111	0,00798	0,167	0,00191	0,000542
0,01	88	0,073	0,00437	0,165	0,000586	0,000135

Calculations have demonstrated that the optimal design is for the loads determined at the unsafe points to be equal; i.e., $q_{01} = q_{02} = q_{03}$; i.e., an equal-strength construction.

A comparison of supporting power findings for ribbed and continuous plates of identical weight demonstrates that optimal ribbing results in a considerable increase in supporting power. And this effect is greater, the lower the value of $\bar{h}_0$. A 4.34-fold increase in supporting power can be achieved with $\bar{h}_0 = 0.01$.

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UDC 66.091

SYNTHESIS OF REFRACTORY MATERIALS IN A COLD CONTAINER

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 6, Jun 86 pp 31-36

[Article by Doctor of Technical Sciences N.A. Iofis, Corresponding Member of the USSR Academy of Sciences V.V. Osiko, Academician A.M. Prokhorov and Candidate of Technical Sciences A.N. Shamov]

[Abstract] Nonmetallic refractory materials are now manufactured by direct high frequency melting in a cold container, with the melt heated by high frequency currents. The substance melted is placed in an envelope of solid polycrystalline material of the same composition as the melt, assuring high chemical purity, allowing melting at an arbitrarily high temperature with no limitations in terms of atmosphere around the melt. The technological equipment used in the process is described. Moscow's "Emitron" plant has developed a waste-free method for production and processing of inanites, in which the material is melted in a cold crucible in an induction furnace, then the crucible is lowered from the induction zone, causing crystalline growth to begin at the bottom of the crucible. The initial materials used in the process are fully converted to the end product. Figures 5.

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HIGH TEMPERATURE TECHNOLOGIES AND MATERIALS FOR METALLURGY

Moscow VESTNIK AKADEMII NAUK SSSR No 6, Jun 86 pp 37-46

[Article by Candidate of Technical Sciences L.I. Danilov, V.K. Kondratev and Doctor of Technical Sciences Ye.M. Shelkov]

[Abstract] The Institute of High Temperatures, USSR Academy of Sciences, Cherepovetsk Metallurgical Plant and Novolipetsk Metallurgical Plant have been cooperating for some years in high temperature research. This article discusses the major results of this creative cooperation. The major areas of study have included high temperature regenerative heaters with elevated blast temperature, improvement of the design and effectiveness of air tuyere devices, studies of the possibility of producing high temperature reducing gas to be fed into a blast furnace to reduce the consumption of coke, and development of special heat resistant alloys for supports for heating furnaces. Figures 3.

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PROPERTIES OF FTORLON FILTER MATERIALS

Moscow IZVESTI"A VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 10, Oct 86 (manuscript received 17 Feb 86) pp 48-51

[Article by Doctor of Technical Sciences, Professor S.V. Belov, Doctor of Technical Sciences, Professor I.N. Kyvarzin, Candidate of Technical Sciences, Docent G.P. Pavlikhin, and Engineer O.V. Kirikova]

[Abstract] Ftorlon porous filter materials Type FEP can remove solid particles over 0.5 μm in diameter from gases and liquids. This article presents results of experimental studies of the structural and hydraulic characteristics of these materials. Porosity was determined by comparing densities of Ftorlon with the porous FEP materials, mean and maximum pore diameters by liquid extrusion. Hydraulic resistance was determined by measuring the flow characteristics of specimens for compressed air in laminar flow. The use of multilayer filter elements can decrease the hydraulic resistance of filters while increasing their service life. The effective pore size of two-layer filters is determined by the pore size of the layer with the smaller particles, while replacement of a portion of the material with a layer with larger pores reduces effective hydraulic resistance of the entire filter. References 4: Russian.

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STUDY OF STRENGTH OF REINFORCED POLYMER COATING UNDER BENDING AND TENSIONING OF SUBSTRATE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 10, Oct 86 (manuscript received 25 Mar 86) pp 3-9

[Article by Candidate of Technical Sciences S.I. Koryagin]

[Abstract] Several forms of failure of metal-reinforced polymer coating composite materials are analyzed. The specimens were made of Type 3 steel [carbon steel with 235 MPa elastic limit] reinforced with a glass fabric ocating in Type VAK-A adhesive binder. Reference points were applied to the polished metal surface before the experiments, then the distances between reference points was measured after deformation in a tensile test machine. Failure due to shear between glass fabric layers was observed only in bending tests with a concentrated load and low ratio of span length to section height. In all other types of bending, failure of the material occurred in the compressed zone. In both bending and tension tests, the coating delaminated before the elastic limit of the base material was reached. Adhesive strength was responsible for failure of the composite material. When the polymer material reinforced with glass fabric lost stability, fibers broke and subsequently separated from the substrate, so that the failure of the reinforced polymer coating was a complex phenomenon. References 6: Russian.

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UDC 62-762.426

STRUCTURAL, HYDRAULIC AND FILTER PROPERTIES OF POROUS TITANIUM

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: MASHINOSTROYENIYE in Russian No 12, Dec 86 (manuscript received 11 Apr 86) pp 137-140

[Article by Doctor of Technical Sciences, Professor S.V. Belov, Engineer V.G. Govorov and Candidate of Technical Sciences N.G. Prikhodko]

[Abstract] A study is made of the structural, hydraulic and filter properties of specimens of porous titanium obtained by vacuum sintering of spherical titanium particles in ceramic or graphite molds without losing the shape of the particles. Studies were performed on disk specimens 30 mm in diameter, 5, 7 and 10 mm thick. The properties were found to be quite smaller to the analogous characteristics of porous bronze produced by sintering of the same fractions of powder. Figure 1; references 4: Russian.

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NON-STATIONARY TEMPERATURE DISTRIBUTION IN SOLIDS

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 29 Dec 84) pp 63-67

[Article by O.P. Sidorov]

[Abstract] When a body has a definite shape and the intitial condition does not change, it is sufficient to solve a differential heat equation only once, and it will be valid for any homogeneous material the body is made of. A nonlinear heat equation was presented which lends itself to precise linearization. The linear equation was derived. It was assumed that the thermal conductivity coefficient, heat capacity and thermal diffusivity was examined; the solution was presented earlier by another author. With certain substitutions, the derived heat equation coincides with the heat equation in that other work. Figures 3; references 4: Russian.

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ION FORMATION DUE TO PHYSICAL ADSORPTION OF NEUTRAL MOLECULES ON SOLID SURFACES

Kazan IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: AVIATSIONNAYA TEKHNIKA in Russian No 4, Oct-Dec 85 (manuscript received 18 Apr 85) pp 60-63

[Article by G.P. Potapov]

[Abstract] Electrophysical properties of a low-temperature gaseous atmosphere were examined. The mechanism of ion and electron formation during a non-equilibrium chemical reaction of graphite burning was studied, wherein the prespecified gas composition in terms of concentration of aerosol particles and polar gas molecules that interact with the aerosol particles was taken into account. This interaction is possible when binding energy is higher than mean kinetic energy of molecules, whereas ionization relaxation time is shorter than the time the gas spends at the wall surface. An expression for the equilibrium charge of an aerosol particle was derived. Then an expression for the flow of desorbed particles (ions) was derived. Using an expression for an aerosol particle charge, concentration of desorbed ions was determined. It was demonstrated that ionization velocity depended on concentration and selectivity of polar molecules of gas mixture, wherein the molecules could have either a natural or induced polar moment, for instance, due to the effect of electrical fields or other external forces. Depending on the thermodynamic state of the gas mixture, processes, related to ion decay, can take place in the mixture. To prove the proposed ionization model, quantitative estimates

of electron concentration in a jet stream were presented in a Table. It could be seen from the Table that the order of values of electron concentration, determined while taking into account physical adsorption of polar molecules on aerosol particles, coincided with experimental data. Figure 1; table 1; references 9: 8 Russian, 1 Western.

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